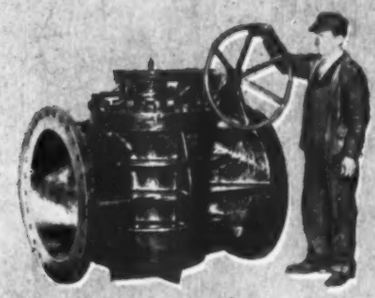
JAN 27 19

Bridge to Valveland: The engineers who laid out the magnificent San Francisco-Oakland Bridge certainly selected a fine location for its eastern terminal. It ends right at the largest and finest plug valve plant in the world. You guessed it—Nordstrom's western plant at Oakland.



Sizable, to Say the Least: A valve big enough to walk through. The biggest plug valve ever constructed. It's a Nordstrom, 30" size, one of many installed in Pennsylvania.

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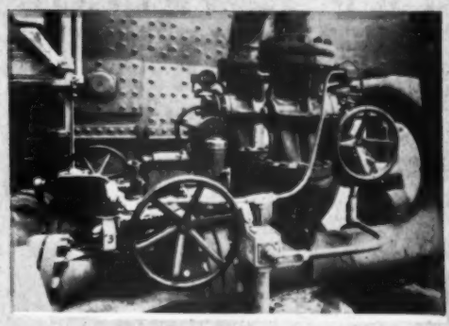

Bridge Ahead: On the towering Carquinez Bridge spanning the junction of San Francisco Bay and Sacramento River, these Nordstrom Valves are installed on the gas lines. Remote-controlled, electrically operated. Made of cast steel.

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THE Petroleum Engineer

JANUARY 1938

VOLUME IX NUMBER 4

A MAGAZINE OF METHODS FOR OPERATING MEN

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MEETINGS

American Institute of Mining and Metallurgical Engineers, Annual Meeting — February 14, 15, 16, and 17, Engineering Societies Bldg., New York City.

American Petroleum Institute, Division of Production, Mid-Continent District, Spring Meeting—February 17 and 18, Herring Hotel, Amarillo, Texas.

American Society for Testing Materials, Spring Regional Meeting and Group Committee Meetings—March 7, 8, 9, 10, 11, and 12, Seneca Hotel, Rochester, New York.

American Association of Petroleum Geologists, 23rd Annual Meeting—March 16, 17, and 18, Roosevelt Hotel, New Orleans, Louisiana.

American Petroleum Institute, Division of Production, Southwestern District, Spring Meeting—March 24 and 25, Blackstone Hotel, Fort Worth, Texas.

Petroleum Industry Electrical Association—April 13, 14, and 15, Rice Hotel, Houston, Texas.

American Chemical Society—April 17, 18, 19, 20, and 21, Dallas, Texas.

American Petroleum Institute, Pacific Coast District, Division of Production, Spring Meeting—April 19, Biltmore Hotel, Los Angeles.

Western Petroleum Refiners Association, Annual Meeting—April 25, 26, and 27, Hot Springs, Arkansas.

American Petroleum Institute, Division of Production, Eastern District—April 28 and 29, William Penn Hotel, Pittsburgh, Pennsylvania.

Natural Gasoline Association of America, Annual Convention—May 11, 12, and 13, Hotel Tulsa, Tulsa, Oklahoma.

International Petroleum Exposition—May 14, 15, 16, 17, 18, 19, 20, and 21, Tulsa, Oklahoma.

American Petroleum Institute, Eighth Mid-Year Meeting — May 23, 24, and 25, Wichita, Kansas.

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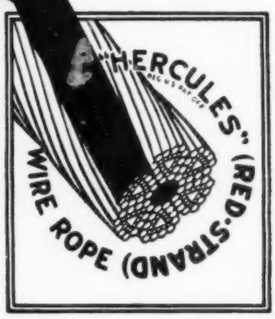

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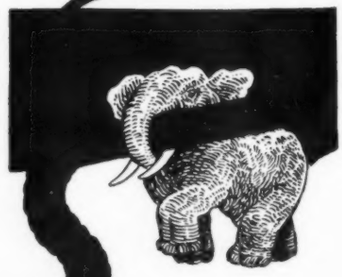

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The Course of Oil

By K. C. SCLATER

Reducing Basic Costs

One main objective in engineering is to reduce basic costs of production. Sound means for accomplishing this objective may be offset by extraneous conditions beyond the control of the engineer. Until quite recently, the tacit adherence of operators to the "law of capture" dogged the petroleum engineer in his efforts to produce oil efficiently. Difficulties arising from this particular source have been largely eliminated, though there still are extraneous factors that hinder the application of engineering methods that result in the greatest ultimate economic recovery from a pool.

For example, good engineering dictates that the allowable in the East Texas field should be reduced, but because of the State marginal well law the regulation authorities seem to be reluctant to do so. Whether the power granted the Railroad Commission for preventing waste supersedes the restrictions of the marginal well law is in question; but the fact remains that the economic life of the field will be seriously shortened if the field is allowed to produce at its present rate. Some operators protest a reduction, contending only that other fields in the State should be reduced accordingly; they disregard entirely the controlling factor—or what should be the controlling factor — reservoir conditions. Experts are even brought forth as witnesses to testify against the reduction of field allowables. One such witness recently testified to the effect that in producing wells, particularly in the Gulf Coast, it may be necessary to lift several hundred barrels of water daily to recover any oil and that the production of large volumes of water must be maintained or the oil trapped beyond hope of recovery. On the face of it, this statement conflicts with what is regarded as sound production practice; rather, it is the very antithesis of good production practice. It harks back to an old idea that commonly prevailed 10 or 15 years ago. It is to be regretted that the adoption of good production practice should be thwarted by testimony of this kind.

In refining and natural gasoline manufacture there are also extraneous obstacles that offset the work of the engineer in his efforts to reduce the basic costs of production. Gasoline is at present selling below the cost of manufacture apparently because of failure to balance the refinery runs throughout the year in a manner that would compensate for the seasonal demands of gasoline and fuel oil.

Despite these obstacles, petroleum technology is coming into its own. Most of the new pools discovered in 1937 are under conservative development. Spacing rules have been adopted and the calculation of allowables in many instances—particularly in the State of Texas — involves the consideration of acreage factor, gas-oil ratio, and the bottom-hole pressure of the well. This is a far cry from the arbitrary field regulations, or lack of them, of a few years ago. Though regulations, from the standpoint of good engineering practice, still leave much to be desired, substantial progress has been made. Operators realize the stabilizing benefits that accrue from wise curtailment of production, and resistance to putting into effect sound regulations has diminished. Resistance now experienced in this connection is confined largely to some of the older flush fields that were first developed without regard to proper reservoir control.

Technology in the refinery has also kept pace in reducing basic costs, one piece of evidence of which is that polymerization plants are now in general use for the manufacture of high anti-knock blending naphthas from refinery gases. Gases that formerly were dissipated into the atmosphere are now economically processed into valuable products. It has been estimated that the total capacity of polymerization plants in the U. S. A. is 25,000 barrels, the equivalent gasoline production from 55,000 barrels of crude oil a day.

The metallurgist has also been active in increasing the efficiency of refinery operations and reducing basic costs by the development of corrosion-resisting and heat-resisting metals.

There is every reason to believe that good engineering practices will continue to be enforced by the Railroad Commission of Texas. This is important to the industry, for the oil operations in Texas affect those of the entire country. Col. E. O. Thompson in his year-end statement said, "I can think of no science that has been developed so fast in the last few years as that of petroleum engineering. The regulatory authorities have availed themselves of the expert testimony furnished by competent petroleum engineers. The conclusions and suggestions of these engineers have been subjected to the acid test of open, frank, free discussion with questions and answers by anybody, in open hearings; and the industry has come to trust these findings of fact thus arrived at."

This statement augers well for the continued adoption of sound engineering principles to the regulation of oil production in Texas, and further reductions in basic production costs throughout the industry.

Trend of Crude Stocks

Based on the number of days supply of crude in stock the current threat of overproduction can be subjected to a reliable appraisal. The average number of days supply at the beginning of each month in 1933 was 140.5 days; 1934, 135.3 days; 1935, 117.0 days; 1936, 98.5 days; 1937, 86.3 days. These figures are based on data from the U. S. Bureau of Mines. They afford a better picture of the trend of crude oil stocks than figures expressed in round numbers of barrels. Up to the end of 1937 the trend is encouraging. The threat of overproduction should be heeded if this favorable trend is to be maintained.

« « HIGHLIGHTS IN OILDOM » »

Kentucky Operators Favor Water-Flooding

Operators in Kentucky, representing 80 percent of the state's crude oil production, have gone on record as favoring a bill to legalize water-flooding to increase recovery of oil. The matter was the principal topic considered at a recent meeting in Louisville of the Kentucky Oil and Gas Association and those present voted unanimously to support such a bill.

The water-flooding law now in effect in the State of Pennsylvania was read and members of the association agreed that the Kentucky law should be essentially a duplicate of the Pennsylvania law.

●

Special Session May Consider Tideland Drilling

A special session of the California Legislature, principally for the purpose of considering tideland drilling, has been indicated by Governor Merriam. Two measures relating to tideland drilling, the O'Donnell and the Olson bills, both are held up at present by referendum petitions. These two bills, however, dealt only with the tideland drilling situation at Huntington Beach, and it is believed that further legislation on the subject will take into consideration the entire coastline of California.

●

New Zealand Plans to Control Oil Exploration

The annual report issued by the Taranaki (New Zealand) Oil Fields refers to a recent statement made by the New Zealand Minister of Mines that the government intends to introduce legislation to control the possible future search for oil fields in New Zealand. The government has intimated that it proposes to claim oil contained in any land of the Dominion as Crown property, and that it will issue regulations governing any concessions to private interests for drilling purposes.

It is reported that foreign interests are negotiating for drilling rights on the east coast of the North Island pending the enactment of the proposed legislation, which, it is asserted by the government, is intended to protect the claims of concessionaires as well as the public's interest in the conservation of national oil resources.

●

Petroleum Prospecting in Madagascar

Search for petroleum in Madagascar since 1932 has been made jointly by the Government of Madagascar, the National Office of Liquid Fuels, and the French Petroleum Company (Compagnie Francaise des Petroles). The sum contributed by each is 3 million, 3 million, and 5.7 million francs, respectively.

In addition to geological research, two shafts were sunk in the Andrafiavelo area to a depth of 400 meters, plutonic rock being found. A third shaft in the bituminous sandstone area near Folkora has reached a depth of more than 900 meters, disclosing two petroliferous levels the importance of which has not been determined. Consequently the colony of Madagascar was authorized by a recent decree to spend an additional 4½ million francs for this work prior to 1943.

First Shipment of Helium to be Made Feb. 1st

About February 1st the German steamer Dessau will leave the Port of Houston (Texas) with the first shipment of helium gas to be transported from the United States. The steamer will take a portion of the 17,900,000 cu. ft. of helium ordered for the LZ-30, sister ship of the zeppelin Hindenburg, destroyed by fire May 6, 1937, at Lakehurst, New Jersey. The LZ-30 will be launched in about five months.

Aboard the Dessau are 468 steel bottles to be used as containers for the non-inflammable gas, which the United States government owns exclusively. The gas will be transported to Houston in railroad tank cars from the plant near Amarillo, Texas.

The 2,350,000 cu. ft. of gas to be placed aboard the Dessau will virtually exhaust the supply in the Amarillo plant. Helium is difficult to store and limited amounts are kept on hand. More helium will be refined immediately for the next shipment to Germany and for use in the United States.

●

Granted Exploration Rights in Guatemala

Executive orders have been issued by the Guatemalan government authorizing explorations in the concession of the Compania Guatemalateca de Petroleo Shell. The concession consists of approximately 3,100,000 hectares.

By terms of an agreement with the Shell company, the Izabal-Castellanos Company, former concessionaire, will receive 101,283 quetzal (the exchange value of a quetzal is $1.00) and, in addition, during a period of two to three years, 20 cents for each hectare of land that the Shell company may exploit and that may have belonged to the former concessionaire, and two and a half cents per bbl. gold on the gross amount of petroleum that Shell produces from the area. At the expiration of that time Shell will then pay two and a half bbl. to the Izabal-Castellanos Company for each 100 bbl. of petroleum produced. Under the same agreement, the Government of Guatemala will receive six bbl. of petroleum for each 100 bbl. produced.

●

Potential Tests For Turner Valley Field, Canada

Operators in the Turner Valley field of Canada recently agreed to a proposal by government officials of Alberta for taking five-day potential tests of wells to determine standards for proration. Potentials established by this method will supersede those previously set following three-day tests.

●

Issue Regulations for New K.M.A. Field

The Texas Railroad Commission has promulgated operating rules for the new K.M.A. deep field in Wichita and Archer counties. A 10-acre spacing is allowed, but the proration unit is 20 acres. Allowables are based 50 percent on acreage and 50 percent on potential.

The rules as promulgated represent a compromise agreed upon by operators at a hearing in Wichita Falls on December 30. The difference in the size of spacing and proration

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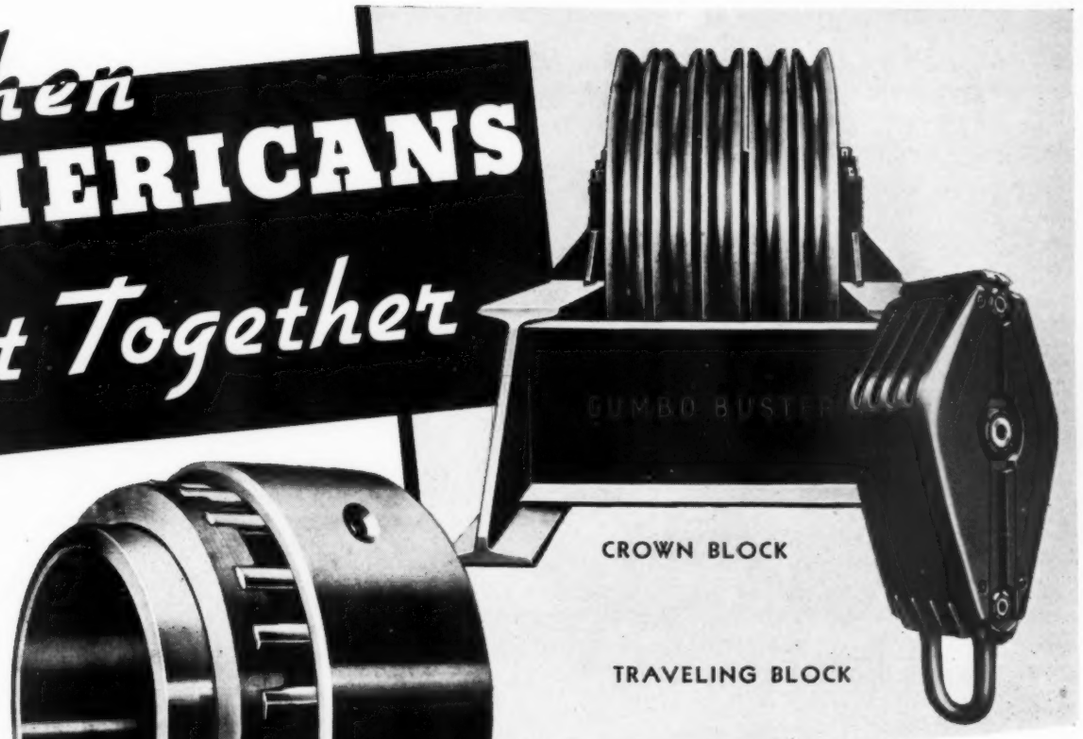
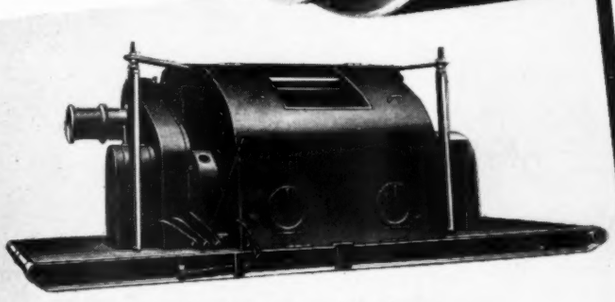
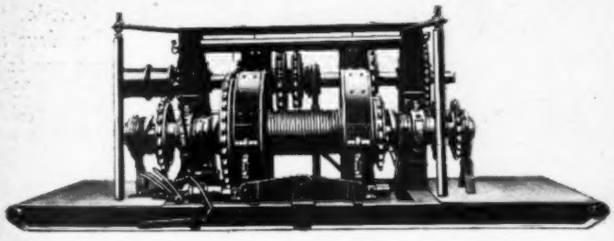




DRAW WORKS *(FRONT VIEW)*



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units is the result of a compromise to meet demands of one group for 20-acre drilling and of another group for continuation of the 10-acre spacing on which many of the older wells were drilled.

●

Orders Water Survey for East Texas

A general water survey in East Texas and status report of wells incapable of making their allowable, pumping wells, water wells, and artificial lift wells have been ordered by the Texas Railroad Commission. The order states the commission has found that information obtained by means of its periodic water surveys has been instrumental in procuring an increased efficiency in production by conservation of reservoir energy and believes the general report would be of additional value.

All operators are ordered to report wells making water, pumping, using air- or gas-lift, or incapable of making their allowable. Operators not having such wells also must make a report.

●

Regulations for Schuler and Rodessa Fields, Arkansas

The maximum per well allowable for lower Marine wells, at a depth of 7500 ft., in the Schuler field of Union County, Arkansas, has been established at 400 bbl. by the Arkansas Board of Conservation. The order became effective January 1st. Well allowables are based 50 percent on gas-oil ratio and bottom-hole pressure and 50 percent on acreage. A 20-acre spacing rule was adopted some time ago.

The Board of Conservation also announces that three substitute proposals for regulation of the Miller County, Arkansas, end of the Rodessa field, to supersede the board's original proration order, have all been rejected, and that the order as first issued October 23 to take effect November 1, and subsequently deferred to January 1, went into effect on the latter date. This order establishes the allowable for the field at 10,000 bbl. a day, based 50 percent on acreage and 50 percent on gas-oil ratios and bottom-hole pressures. The acreage factor caused some of the opposition to the order.

The Arkansas end of the Rodessa field has shown a marked decline in production during recent weeks. Bottom-hole pressures are 1200 to 2250 pounds. One well in the field is an outright gas well, and three others have gas-oil ratios of 51,000 to 1.

●

Supreme Court Supports Oil Law

The United States Supreme Court early this month gave further support to Texas' oil control law by refusing to review a decision of the Circuit Court of Appeals for the Fifth District involving the question of whether the failure of the Railroad Commission to enforce its proration orders upon all operators in the East Texas field constituted unequal protection to citizens in violation of the fourteenth amendment of the constitution. The effect of the court's action was to uphold the decision of the Circuit Court, which held that failure to enforce the orders was caused by lack of funds and inadequate statutory penalties, and, as the failure of the commission was not negligent or wilful, there was no denial of equal protection.

Angus Spear and Thomas D. Humphrey filed the petition for a review of the Circuit Court's decision. The case resulted from an effort on the part of these two East Texas operators to obtain an injunction against the commission under which they could sell and move their oil in excess of their quotas. In asking an injunction the operators complained that, whereas they had observed the production limitation orders of the commission, neighboring operators had not, but had flagrantly and grossly overproduced, causing extensive damage to the petitioners, and the commission had not compelled obedience to the law, although knowing of the violations. They stated that after they had obeyed the proration orders for years and had exhausted every effort to have the commission enforce the law they had resorted to over-production and desired an injunction under which they could sell and move excess oil.

●

Pennsylvania Operators Dissatisfied with Oil Prices

Oil operators in the Bradford area of Pennsylvania in a recent statement intimated that state control of the industry might be sought if coöperation fails to increase and stabilize crude prices at a profitable level. The Pennsylvania Oil Producers' Association at Bradford cited a monthly loss of $1,500,000 and termed "deplorable" the existing price of $2.20 a bbl. for oil in the Bradford-Allegheny field.

The district association declared losses in the Bradford area are $30,000 a day and asked coöperation of refiners in finding a remedy. Losses of all producers in the Pennsylvania grade field, from southwestern New York to northwestern Virginia, was given as $50,000 daily.

●

Gas-Oil Ratio Order Issued For Texas

The Texas Railroad Commission has ordered that all wells completed in any field in which a gas-oil ratio program is in effect and for which a maximum daily gas limit for wells has been established by the current proration schedule shall, within 30 days after a potential test has been taken for proration purposes, be tested for gas-oil ratio in conformance with instructions contained in Form G-O-2.

The order also states that, effective February 1, 1938, all gas-oil ratio test forms (G-O-2), having the information requested thereon filled in, shall be filed in the district office of the Railroad Commission not later than five days after the gas-oil ratio is determined. Should the operator fail to file the G-O-2 test form in an acceptable manner within the specified time limit the effective date of the allowable resulting from such a test shall not extend back more than five days prior to receipt and acceptance of the G-O-2 test form in the office of the deputy supervisor. This five-day provision obtains regardless of whether the gas-oil ratio test is taken during the month in which it is received in the office of the deputy supervisor or any prior month.

These provisions govern the filing of all G-O-2 test forms on all new wells and wells retested for gas-oil ratio that are retested subsequent to the last general survey of the field in which such wells are located. They shall also apply to all G-O-2 forms filed in the interim between two general gas-oil ratio surveys ordered by the commission and to all G-O-2 forms filed, except when these forms are ordered to accompany state-wide E-B reports for any particular month.

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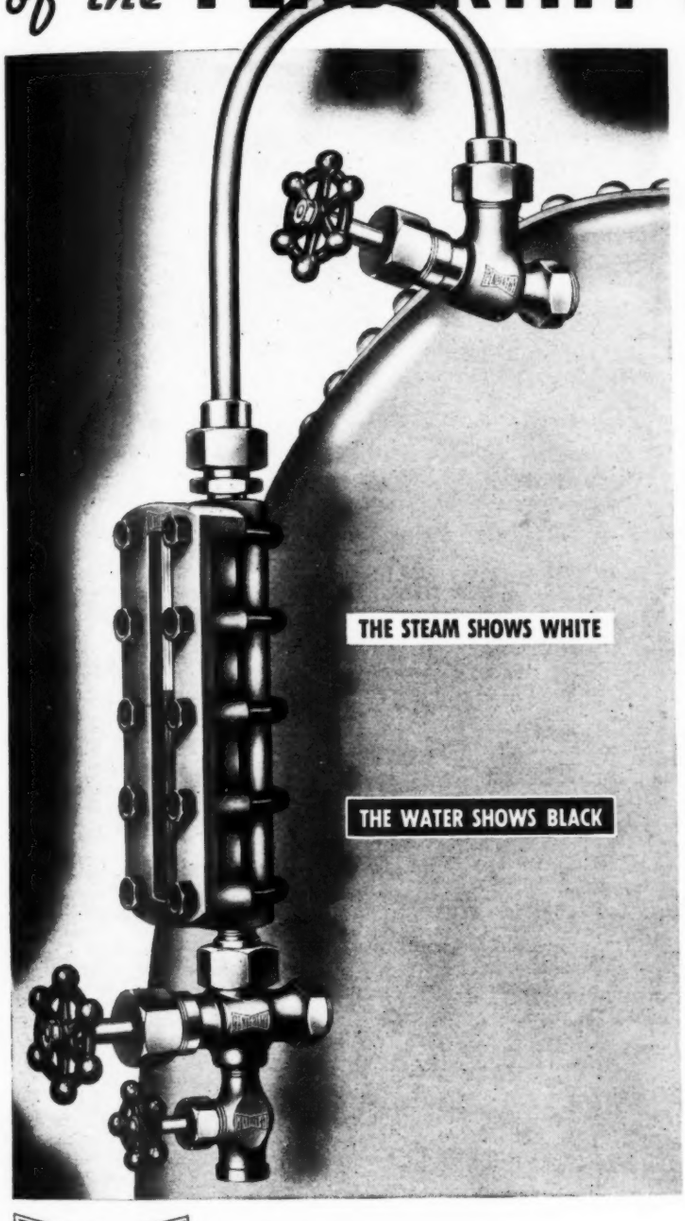

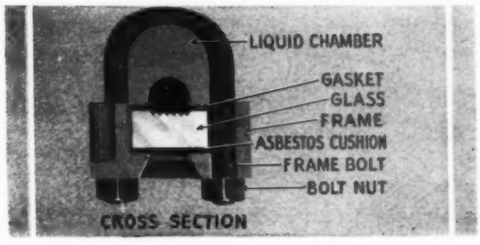

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Note particularly the U-Bolt type of construction that is the strongest and the simplest to service. To replace a glass, simply remove the nuts on the face of the gage . . . it is unnecessary to work between the gage and the boiler.

The Penberthy Reflex Gage shown here is available in both Navy Bronze and Malleable Iron; it is recommended for working pressures to 350 lbs. at 450° F. Gage is furnished complete with Penberthy "Dripless" Drain Cock shown.

Other Penberthy Reflex Gages are made in any length desired for higher pressures and for various kinds of liquids. Any leading oil well supply distributor will be pleased to quote upon your particular requirements.

PENBERTHY PRODUCTS

PENBERTHY INJECTOR COMPANY *Manufacturers of* QUALITY PRODUCTS *Since 1886*
DETROIT, MICH. • *Canadian Plant,* Windsor, Ont.

Latest Activities In The Oil Fields

THE most important discovery in Oklahoma for some time has been made by the Mid-Continent Petroleum Company and associates southwest of Stillwater in Payne County. On Christmas Eve their No. 1 Ramsey showed oil on a test made from the first Wilcox sand. It was deepened to 4796 ft. and shut in. When opened on January 2 it flowed 935 bbl. of oil in two hours. On subsequent tests the well flowed at the rate of 14,000 bbl. a day. The gravity of the crude is 43.2 degrees.

●

The Amerada Petroleum Corporation and the Stanolind Oil and Gas Company have opened a new producing area in Harris County, Texas, northwest of Houston. The well, No. 1 Mills, the total depth of which is 6863 ft., after being washed in, produced 22 bbl. of oil the first hour through a quarter-inch choke. The casing is perforated at 6840-50 feet. The gravity of the oil is 38 degrees.

●

The Texas Company and The California Company's joint discovery well on the Wilson Creek structure, Rio Blanco County, Colorado, 30 miles southwest of Craig, made 50 bbl. of crude an hour through the drill stem from the Morrison formation at a total depth of 6700 feet. The well, No. 1 Freeman-Government, then was drilled to a total depth of 6918 ft., into the Sundance sand, logging 74 ft. of saturated sand at 6824-98 ft., the operators preparing to run a drill-stem test. This is being looked upon as a most important discovery in the Rocky Mountain area.

●

Sun Oil Company's No. 1 Bay Shore Farms, one and a half miles north of Palacios, Matagorda County, Texas, blew out and caught fire while testing production through perforations. After being extinguished and brought under control the well flowed at the rate of 500 bbl. of distillate daily through ¾-in. choke. Total depth of the well is 11,327 ft., but the producing sand was drilled at 9245 to 9275 feet.

A new pool has been opened in Ness County, Kansas, by the Continental Oil Company's No. 1 Olson, one mile north of the Aldrich field. The well had a showing of oil at 4301 ft. and again at 4309 feet. The producing formation, the Mississippi lime, was found at 4314 ft., at which depth oil rose 1100 ft. in the hole. At a depth of 4325 ft. the well swabbed 100 bbl. of oil and two and a half bbl. of water, the test then being plugged back to 4315 ft. for further testing.

●

The Texas Company's No. 1 State Bateman Lake, in St. Mary Parish, south of Morgan City, completed December 26, opens a new field for the Louisiana Gulf Coast, and also is the second deepest producing well in the world. After being drilled to a depth of 11,879 ft., the test was plugged back and casing perforated from 10,900-905 ft., the well coming in flowing at the rate of 350 bbl. of oil daily through 3/16-in. choke. Gravity of the oil is 33 degrees. Tubing pressure in 850 pounds.

●

Recent completion of a well capable of producing 1400 bbl. of oil daily on the western edge of the Montebello field, Los Angeles County, California, definitely proves the Miocene formation productive in that area and is likely to result in renewed activity in this old field. The well, St. Helens Petroleum Company's No. 20 Monterey, is at the intersection of Montebello Boulevard and Lincoln Avenue. The total depth of the well is 6353 ft., and the gravity of the oil is 38 degrees.

●

At Lovells Lake, eight miles southwest of Beaumont, Jefferson County, Texas, McCarthy No. 1 Broussard flowed oil and wash water into the pits after being swabbed for several days. Production was obtained through casing perforations between 7717 and 7732 feet. Casing pressure is 1100 lb.; tubing pressure, 950 pounds.

AVERAGE CRUDE PRICES

California	
Kettleman Hills	$1.19-1.43
Playa Del Rey	.80-1.16
Coalinga	.70- .90
Signal Hill	.80-1.21
Montana	1.35
Wyoming	.97-1.30
Colorado	1.12-1.18
New Mexico	.78-1.08
Texas	
North Central	.96-1.20
Panhandle	.91-1.08
West Texas	.78-1.08
Gulf Coast	.95-1.41
Darst Creek	1.09
East Texas	1.35
Talco	.73
Kansas	.98-1.30
Oklahoma	.98-1.30
Arkansas	.90
Louisiana	
Rodessa	$ .91-1.25
Gulf Coast	.84-1.41
North Louisiana	.90-1.22
Illinois	1.35
Kentucky	1.40
Indiana	1.12
Ohio	
Lima	1.25
Michigan	1.27
Pennsylvania	
Bradford	2.20
Southwest	1.88
Eureka	1.82
Buckeye	1.70
Corning	1.27
West Virginia	1.67
Canada	2.10-2.17

DAILY AVERAGE CRUDE OIL PRODUCTION

Data Supplied by A.P.I.

(Figures in Barrels)

	B. of M. Dept. of Int. Calculations (December)	Week Ended Jan. 1, 1938	Week Ended Dec. 4, 1937	Week Ended Jan. 2, 1937
Oklahoma	588,800	533,700	556,100	579,900
Kansas	186,000	166,600	168,800	165,850
Panhandle Texas	.....	67,450	67,700	67,450
North Texas	.....	73,500	72,350	63,650
West Central Texas	.....	32,700	33,450	32,900
West Texas	.....	194,250	190,050	167,350
East Central Texas	.....	85,800	91,400	95,550
East Texas	.....	491,200	416,900	447,100
Southwest Texas	.....	237,250	240,600	179,850
Coastal Texas	.....	196,750	191,900	170,500
TOTAL TEXAS	1,399,800	1,378,900	1,304,350	1,224,350
North Louisiana	.....	76,400	74,900	80,850
Coastal Louisiana	.....	174,650	171,400	161,350
TOTAL LA.	244,000	251,050	246,300	242,200
Arkansas	33,900	48,800	44,100	28,350
Eastern	126,200	131,750	137,000	119,350
Michigan	51,800	50,100	53,750	27,600
Wyoming	57,100	48,100	48,700	44,400
Montana	15,800	13,750	15,750	17,250
Colorado	4,400	4,400	4,300	3,650
New Mexico	104,100	107,750	104,750	86,200
TOTAL EAST OF CALIF.	2,811,900	2,734,900	2,683,900	2,539,100
California	679,400	701,700	703,100	582,300
TOTAL U. S.	3,491,300	3,436,600	3,387,000	3,121,400

WELLS *HAVE* BEEN DRILLED WITH POOR MUDS

BUT OLD-FASHIONED DRILLING METHODS CANNOT COMPETE WITH MODERN TECHNIQUE

Old-fashioned mud control practices are as out of date as ancient drilling rigs and tools. Present-day operators find that many commonly encountered drilling difficulties can be eliminated or overcome by the use of BAROID Products.

AQUAGEL, by adding gel-forming colloidal material to muds, does much to eliminate the danger of stuck drill pipe and tools. It helps to keep water from entering the formation being drilled, thereby preventing sloughing of the hole.

BAROID, when used as a weighting material in drilling fluid, helps control oil, gas, water pressures and holds caving formations in place. Pumpable muds weighing as much as 19.4 pounds per gallon (145 pounds per cubic foot) have been prepared with BAROID.

STABILITE reduces the viscosities of thick drilling muds, increases their wall-building properties and frees entrained gas. It reduces the danger of gas-cutting and consequent blow-outs.

BAROCO is practically unaffected by salt water, brine or other chemicals encountered in drilling and quickly builds a thin, impermeable wall which checks water from entering formations. One ton of BAROCO will make 40 barrels of excellent drilling mud.

FIBROTEX helps restore lost circulation in gravelly, fractured or creviced formations. FIBROTEX muds seal faster and deposit a thinner filter cake. It is non-abrasive and non-corrosive.

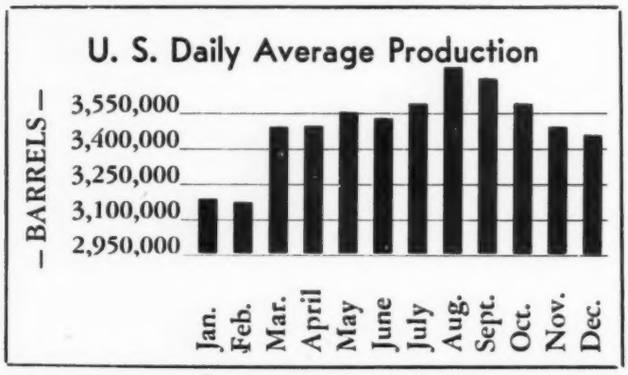
A BAROID Service Engineer can show you that the safest, fastest and most economical drilling is accomplished by using BAROID Products and Service. Ask him for the facts!

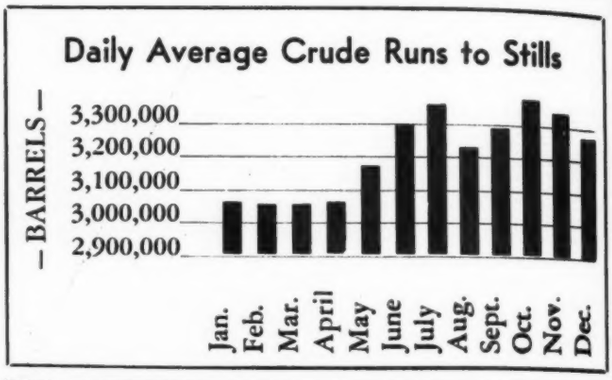
Stocks Carried And Service Engineers Available in All Active Oil Fields

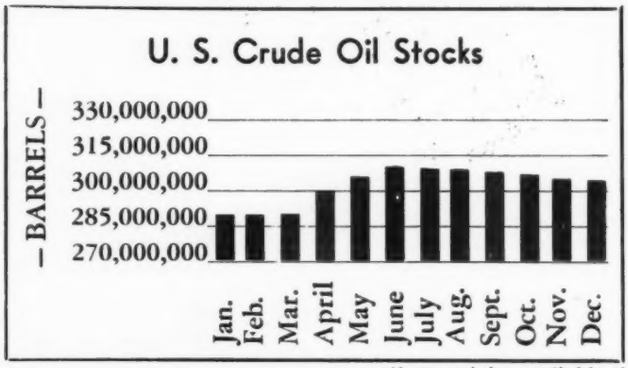
BAROID SALES DEPARTMENT

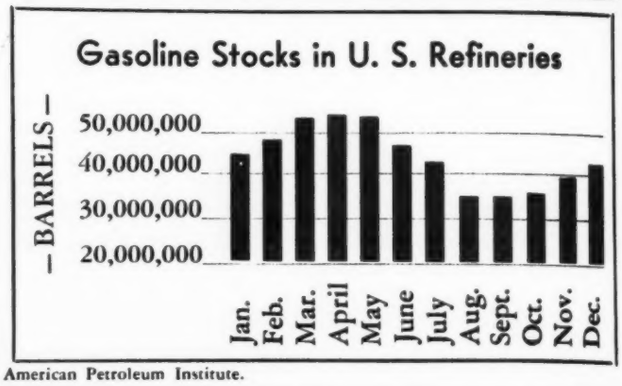
NATIONAL PIGMENTS & CHEMICAL DIVISION OF
NATIONAL LEAD COMPANY
BAROID SALES OFFICES • LOS ANGELES • TULSA • HOUSTON

Summary of Petroleum Statistics and Field Activities









Above statistics supplied by the American Petroleum Institute.

Summarized Operations in Active Fields for December, 1937

Fields	Completions	Producers	Rigs	Drilling Wells	Depth of Production	No. Casing Strings	Gravity of Oil	Type of Tool Used
TEXAS								
East Texas	237	229	39	108	3500-3700	2	40	Rotary
Duval County	27	24	10	39	1554-2900	2	22	Rotary
Ector County	56	56	17	47	3675-4377	2 and 3	32-36	Rot.-Cab.
Panhandle	106	103	56	172	1700-3900	2	40	Rotary
Refugio County	17	16	3	12	4900-5900	2	38	Rotary
Nueces County	37	32	17	55	3922-5878	2 or 3	21-54	Rotary
Winkler County	35	35	10	15	2850-3450	2 and 3	30-38	Rot.-Cab.
Talco Field	33	33	3	21	4230-4361	2	16-24	Rotary
OKLAHOMA								
Oklahoma City	4	4	1	3	6450-6682	3	39	Rotary
Fitts Pool	27	18	3	15	1800-4488	2 or 3	38	Rotary
KANSAS								
Russell County	25	22	11	45	2926-3435	2 and 5	32-37	Rot.-Cab.
Rice County	17	11	6	28	3222-4085	2 and 5	42-48	Rot.-Cab.
Barton County	32	28	9	39	3290-3518	2	39-42	Rot.-Cab.
LOUISIANA-TEXAS-ARKANSAS								
Rodessa	30	29	8	31	5950-6450	3	39	Rotary
ILLINOIS								
Central Illinois	76	42	22	119	2950-4100	2	36-38	Rot.-Cab.
NEW MEXICO								
Lea County	36	35	12	109	3150-4030	3	30-34	Rot.-Cab.
CALIFORNIA								
Kettleman Hills	1	1	2	13	8300-8730	3 or 4	40	Rotary
Wilmington	13	13	18	29	3500-4000	2 and 3	18-20	Rotary

Field Activities by States for December, 1937

State	Completions		Producers		Locations		Rigs		Drilling Rigs		Production, 1936 (In Barrels)
	December	November	December	November	December	November	December	November	December	November	
Arkansas	22	24	17	19	10	20	17	15	46	59	10,461,000
California	101	108	82	95	136	155	109	114	251	259	214,883,000
Colorado	1	1	0	0	.....	.....	2	1	32	36	1,670,000
Illinois	88	73	48	41	.....	14	.....	128	.....	49	4,452,000
Indiana	24	22	17	12	.....	.....	3	2	31	32	795,000
Kansas	195	263	133	209	159	192	59	64	339	369	58,226,000
Kentucky	83	117	59	77	.....	.....	14	16	88	90	5,653,000
Louisiana	67	104	42	74	80	104	47	46	219	236	79,980,000
Michigan	67	83	45	63	67	84	44	54	162	173	11,852,000
Mississippi	2	4	0	0	.....	.....	2	4	14	13	Gas Prod.
Montana	9	17	7	14	.....	.....	3	4	55	64	5,632,000
New Mexico	44	53	41	49	.....	.....	18	21	160	163	27,134,000
New York	7	.....	6	.....	.....	.....	.....	.....	.....	.....	4,637,000
Ohio	125	136	77	90	.....	.....	57	67	196	218	3,834,000
Oklahoma	205	216	142	164	187	216	49	48	377	381	206,082,000
Pennsylvania	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15,830,000
Texas	1183	1199	966	997	1535	1116	387	404	1462	1537	391,097,000
West Virginia	88	123	72	112	.....	.....	30	32	201	205	3,903,000
Wyoming	11	10	7	9	.....	.....	12	10	68	72	13,650,000
Total	2322	2553	1761	2025	2174	1901	853	1030	3701	3956	993,942,000

Dowell's front-rank position among oil producers stands on these fundamentals:

Dowell originated and perfected *Inhibited* Acidizing.

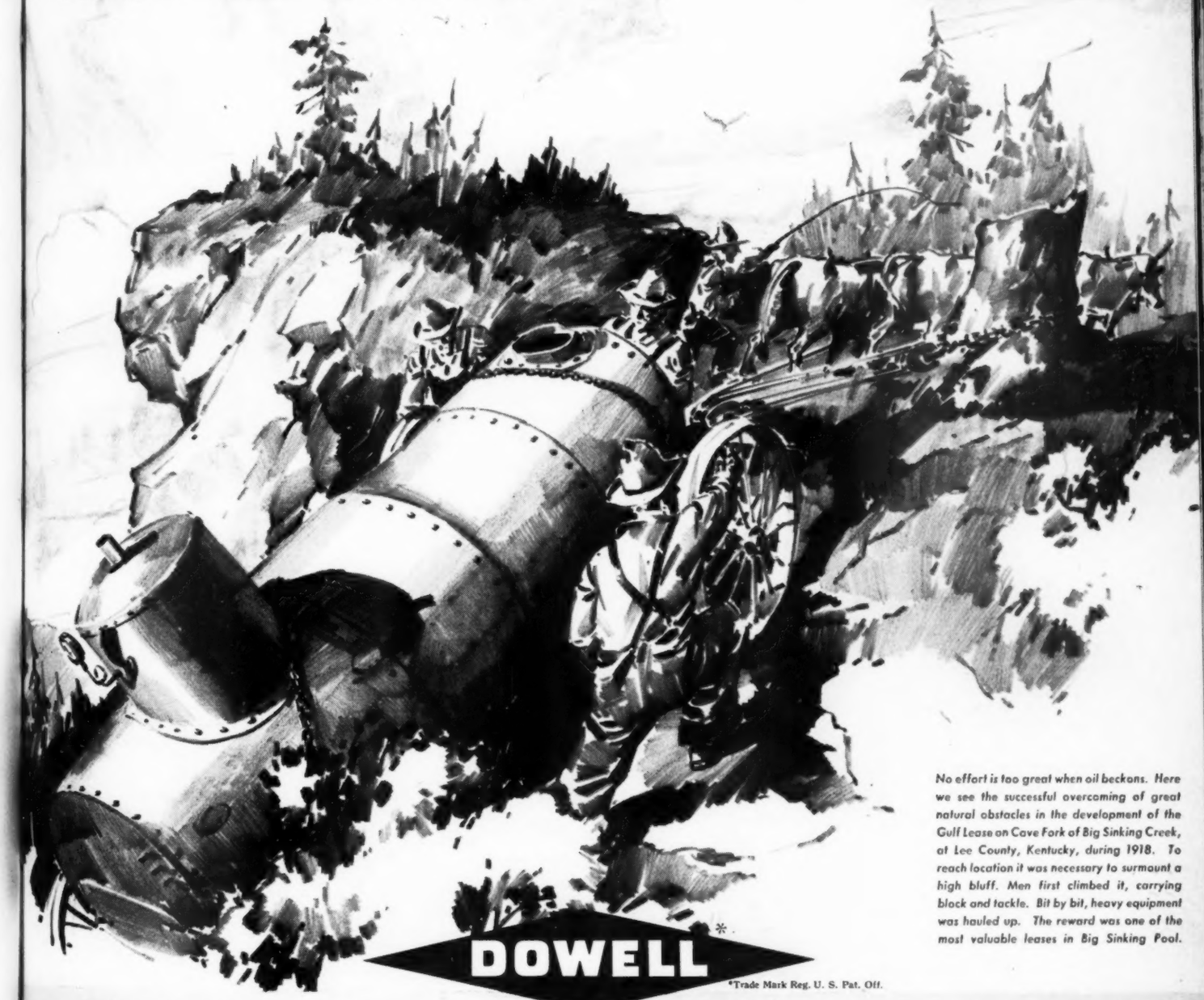
It possesses an unequalled knowledge and experience in well treating.

It has established a service organization beyond comparison—in equipment and personnel.

It continues to bring new (not borrowed) ideas to the oil industry—the results of its own intelligent, earnest research.

●

The great majority of oil producers recognize that Dowell delivers more than a full dollar's worth of results for every dollar spent—and they give Dowell their business.



No effort is too great when oil beckons. Here we see the successful overcoming of great natural obstacles in the development of the Gulf Lease on Cove Fork of Big Sinking Creek, at Lee County, Kentucky, during 1918. To reach location it was necessary to surmount a high bluff. Men first climbed it, carrying block and tackle. Bit by bit, heavy equipment was hauled up. The reward was one of the most valuable leases in Big Sinking Pool.

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LONG BEACH, CALIFORNIA • McCAMEY, TEXAS • MIDLAND, TEXAS • MONOHANS, TEXAS • MT. PLEASANT, MICHIGAN • NEWTON, KANSAS • OKOTOKS, ALBERTA • SEAGRAVES, TEXAS
SEGUIN, TEXAS • SEMINOLE, OKLAHOMA • SHELBY, MONTANA • SHREVEPORT, LOUISIANA • STAMFORD, TEXAS • STONEWALL, OKLAHOMA • TULSA, OKLAHOMA • WICHITA, KANSAS

OIL AND GAS WELL CHEMICAL SERVICE

Progress of Major Pipe Line Work

THE Shell Petroleum Corporation's gasoline pipe line from its refinery at Wood River, Illinois, to Indianapolis, Indiana, now under construction, will be extended to Toledo and Columbus, Ohio, it has been announced by officials of the company. From Wood River to Lima the line will be laid of 8-in. pipe. At that point the line will branch, a 6-in. line going to Columbus and another of the same diameter to Toledo. The length of the line will be 417 miles. Total cost of the project is estimated at $5,000,000.

The route of the line is through Effingham, Terre Haute, Indianapolis, Muncie, Lima, to Toledo, and as stated, at Lima the line branches to go to Columbus. Three electric pumping stations will be erected, and the capacity of the line will be 25,000 bbl. daily.

The new line will give Shell more ready access to distributing centers in Indiana, Ohio, and Michigan. From Toledo it will also be possible to ship via tanker to other Great Lakes cities. At present lake shipments are made by Shell from Chicago, which are not possible in the winter time. Shipping from Toledo is not possible the year around, either; however, the lower lakes are open earlier to navigation than are the Straits of Mackinac, the passage from Lake Michigan to Lake Huron.

●

The Bell General Transit Corporation has been formed and by February 1st, according to officials of the company, the East Texas field will have another major pipe line outlet. The company has acquired the 45-mile, 8⅝-in. line of the McMurrey Pipe Line Company extending from Overton to Tyler, Texas, and a line of the same diameter is being laid from the latter point to the Bullard Station of the Pure Oil Company, which is on the main line of that company from the Van field to Smith's Bluff. The new firm will operate its line from Overton to Bullard as a common carrier, and it and the Pure Oil Company will publish joint tariffs for the movement of East Texas crude to the Gulf of Mexico. A large part of the crude oil to be transported by the new line will be that purchased by the Bell General Pipe Line Company, but it also will carry oil for other shippers. The Bell General Pipe Line Company has contracted with the Pure Oil Company for terminal rights at Smith's Bluff. The capacity of the line will be 30,000 bbl. a day.

The Bell General Transit Corporation, having its executive offices in Tulsa, Oklahoma, has the following officers: Albert Finston, vice-president and general manager of the Bell Oil and Gas Company, president; D. D. Irwin, Chicago, vice-president; Marvin McMurrey, Tyler, vice-president of the McMurrey interests, vice-president; A. H. Meadows, Dallas, secretary; Benedict I. Lubell, Tulsa, treasurer; and M. V. Keeley, Chicago, assistant secretary-treasurer.

●

The right-of-way is being surveyed for a 28-mile, 6-in. pipe line from the Lisbon field, northwest Louisiana, to a point on the Louisiana and Arkansas Railroad near Minden. The line will be laid for Clyde Barbour and Gil Woods, who have announced they will pay the regular gravity scale price of $1.10 a bbl. for Lisbon crude. The Caddo Crude Oil Purchasing Company (Grogan) and the Gulf Refining Company recently reduced their purchasing price to 98 cents a barrel. Barbour and Woods announce they have obtained contracts for 53 connections in the field, representing approximately one-third of the total production. In addition to the main line a gathering system will be laid.

●

The Colombian Petroleum Company, controlled by the Socony-Vacuum Oil Company, Inc., and The Texas Corporation, has been provided with $15,000,000 new capital for development during the year of the Barco Concession in eastern Colombia, South America. It is believed that the development program will include the laying of a pipe line over the Andes. Construction of a pipe line from the concession to a Colombian port when production reaches 20,000 bbl. a day is one of the requirements of the concession. Recently, too, The Texas Corporation, through its New York office, is said to have asked pipe mills for quotations on 25,000 tons of 12¾-in. line pipe, which would total 220 miles, adding further to the belief that a pipe line may be laid in Colombia.

●

The Humble Pipe Line Company has two projects under way in Jones County, Texas, that will give all fields in the area a pipe line outlet. A tie-in is being made to the company's trunk line that crosses the county. The new line will extend several miles to the south. Another line, a 4-in., will be laid to connect the Avoca field in northeastern Jones County with the Hawley pump station. From this 4-in. line a branch will be laid to the Lewis pool.

●

Several pipe line projects have been announced for the Corpus Christi area of Texas, all by the Southern Pipe Line Corporation. Approximately three miles of 20-in. line will be laid from the absorption plant of the Southern Minerals Corporation in the Saxet field to the proposed carbon black plant of the Columbian Carbon Company, which is to be constructed northwest of the field. Another pipe line will be laid from the Richard King field to the Crude Oil Pipe Line Company's carrier just north of Agua Dulce. This will be a 4-in. line. Approximately eight miles of gathering lines, ranging in size from 4 in. to 16 in., will be laid in the Saxet field for the gathering of casinghead gas.

●

The Southern Natural Gas Corporation has added facilities at three compressor stations and constructed a new station at Birmingham, Alabama, to handle an increased gas load in the southeast. At the new Birmingham station three 1000-hp. twin-tandem, double-acting, gas-driven compressors were installed. At Perryville, Louisiana, two 1300-hp. compressors and the necessary auxiliary equipment and building extension were added. At the Onward, Mississippi, station one 1300-hp. compressor was installed, and at Louisville, Mississippi, two new 1300-hp. compressors were added.

●

Reports indicate that the Texas-New Mexico Pipe Line Company is planning to lay approximately 175 miles of 8-in. pipe line from its Crane Station in the Church-Fields area, Crane County, Texas, northward through Ector, Andrews, Gaines, and Yoakum counties to The Texas Company's producing properties in the Slaughter pool of Hockley County.

●

According to the press of Iraq, the Iraq Petroleum Company will construct another pipe line in that country. Apparently the existing line is inadequate to satisfy present requirements.

Pre-determined PERFORMANCE!

Fig. 1742. GASO Duplex Piston Timken Bearing Pump — Electric Drive — 54 to 250 Bbls. per Hr.

● The ship has not yet taken its baptismal plunge, but already its success is assured. When established engineering principles are observed, only one result is possible.

Through long, intensive experience GASO engineers have learned the principles that lead to long, vigorous pump life. And because every GASO embodies these principles, each is pre-destined to deliver that EXTRA service which is the foundation of Gaso's supremacy in its field.

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GASO PUMPS

for every oil industry need

The Month's Activities in Refining

Percent Refinery Capacity Operated

Western Division, 60.7 Percent **Central Division, 78.0 Percent** **Eastern Division, 84.6 Percent**

THE carrying out of plans for the construction of two new refineries in northern Montana, which would receive their crude supply from the Cut Bank field, would aid greatly, and possibly solve, the problem of under-consumption in the area. The Yale Oil Corporation of Billings plans the erection of a 1000-bbl. topping plant at Kalispell in Flathead County, which likely will be in operation late in March or early in April. Negotiations are being made with officials of the Globe Oil and Refining Company to interest them in constructing a 4000- or 5000-bbl. plant either at Shelby, Montana, or a rail division point in North Dakota.

●

The Bay Petroleum Corporation's refinery at McPherson, Kansas, damaged by fire recently, will be rebuilt, it has been announced. The fire originated in the cracking tower and spread to the rest of the plant. This plant was operated by the Dickey Refining Company until June, 1937, at which time it was sold to the Bay company.

●

The enlarged and remodeled refinery of the Consumers Oil and Refining Company at New Castle, Wyoming, has been placed in operation. Capacity of the plant now is 1500 bbl. daily. Included in the new equipment are facilities for blending tetraethyl lead with the gasoline.

●

The Oriental Refining Company, a subsidiary of the Oriental Oil Company, has purchased the plant of the Denver Refining Company at Denver, Colorado, and plans to increase its capacity to 1500 bbl. per day. The same company is erecting a 1500-bbl. refinery at Cowley, Wyoming, in Big Horn County. The source of crude supply will be the Byron and Garland fields. Construction of this refinery was begun by W. O. Taylor and is being completed by the Oriental Refining Company.

●

The refinery being constructed in Japan by the Maruzen Oil Company will be completed in the near future. It will have a daily capacity of 14,200 bbl. and will be the largest modern oil refinery in Japan.

●

Construction of the refinery that the Manchester Oil Refinery, Ltd., is erecting at Barton, near Manchester, England, is progressing rapidly. By the latter part of January it is expected the distillation equipment will be in operation, and by the end of February the solvent extraction and dewaxing equipment should be ready. Immediate plans are for the manufacture of high-grade solvent-refined lubricants and transformer oil principally. In addition, gas oil, fuel oil, and asphalt will be made. The capacity of the plant will be 100,000 tons of crude oil annually.

●

The Aldon Gasoline Company's vapor-rectification type gasoline plant in the Burrton pool, Reno County, Kansas, has been completed and placed in operation. The plant has a daily capacity of 10,000,000 cu. ft. of gas. A. M. Ballard is president of the company and R. J. Wallace is vice-president.

●

A gasoline plant of 4,000,000-cu. ft. capacity has been completed in the K.M.A. field of Texas by the Deep Oil Development Company. Residue gas is being used for repressuring.

●

The Pure Oil Company has announced a construction project at its Smith's Bluff, Texas, refinery involving the expenditure of $3,000,000. Capacity of the plant will be increased from 40,000 bbl. to 65,000 bbl. daily by the addition of new equipment. The Lummus Company is the contractor.

●

The natural gasoline plant being constructed in the Billings field, Noble County, Oklahoma, by the Continental Oil Company is nearing completion. The capacity of the plant will be 20,000,000 cu. ft. daily, gas being taken from wells of the Continental, the Tide Water Associated Oil Company, and other operators in the field. Residue gas will be used for repressuring and for commercial purposes.

Crude Runs to Stills, Gasoline and Gas and Fuel Oil Stocks
Week Ended January 1, 1938

A.P.I. Figures

(Figures in Barrels of 42 Gal. Each)

DISTRICT	Percent Potential Capacity Reporting	Daily Avg. Crude Runs to Stills	Percent Operated of Total Capacity Reporting	Total Motor Fuel Stocks Thousands of Bbl.	Gas and Fuel Oil Stocks Thousands of Bbl.
East Coast	100.0	577,000	86.2	18,228	12,339
Appalachian	88.4	107,000	82.9	3,058	1,145
Ind., Ill., Ky.	92.4	414,000	84.7	12,236	6,815
Okla., Kans., Mo.	84.7	248,000	64.8	6,960	3,724
Inland Texas	56.6	125,000	62.2	2,434	1,793
Texas Gulf	95.7	742,000	93.1	11,157	10,925
La. Gulf	96.6	145,000	86.3	2,364	3,439
No. La.-Ark.	63.7	48,000	82.8	427	499
Rocky Mt.	69.7	29,000	46.8	1,691	617
California	90.9	550,000	73.7	14,376	74,574
Reported	89.0	2,985,000	80.6	72,931	115,870
Est'd Unreported	.....	335,000	.....	4,360	2,790
*EST'D TOTAL U.S. Jan. 1, '38	.....	3,320,000	.....	77,291	118,660
*EST'D TOTAL U.S. Dec. 25, '37	.....	3,245,000	.....	74,437	118,659
U.S. B. of M. *Jan. 1, 1937	.....	**3,002,000	.....	63,344	106,868

*Estimated Bureau of Mines basis.

**December, 1936, daily average.

THE Petroleum Engineer

JANUARY, 1938

Portable Rotary Rigs Expedite Drilling of Shallow Wells

Units evolved from coring machines are particularly adapted to exploration

By LEO H. TOWERS

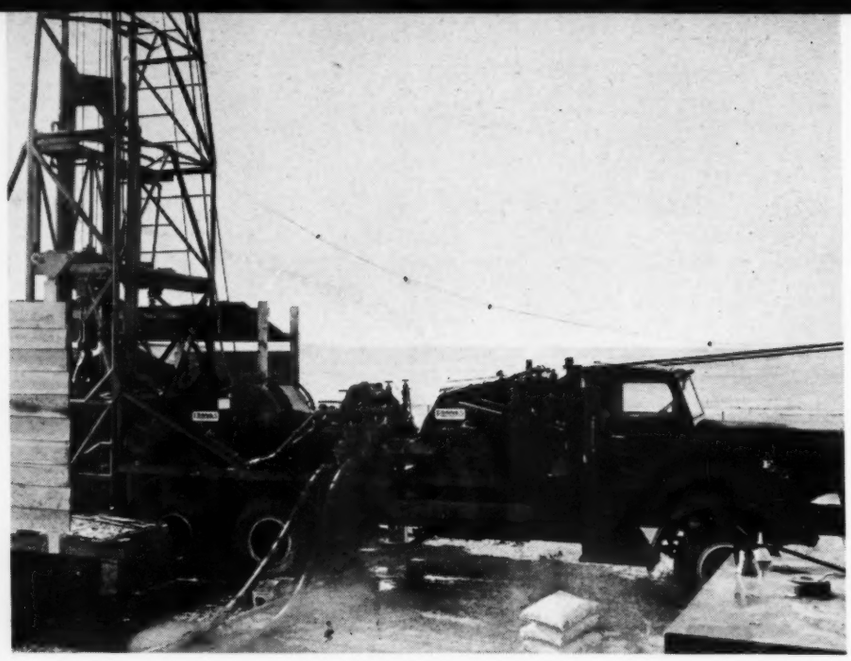
THE increasing search for oil in shallow fields may be accelerated by the introduction of light rotary equipment. Thousands of acres of unproved or semi-proved leases throughout the Mid-Continent area, where production may be found at depths not exceeding 3500 ft., can be explored at a reasonable cost using these units. The payment of rent to hold likely but unproved acreage can be either justified or obviated. The speed of drilling shallow wells by the rotary method should stimulate water-flooding operations requiring new wells.

At least five major operators are experimenting with equipment of this nature in widely scattered areas of Kansas, Oklahoma, and Texas, and a test probably will be made in the Illinois Basin area soon.

The portable rotary drilling unit is the outgrowth of the small coring machines that have been in use for several years. The larger and heavier portable equipment will drill a 6½-in. hole to a depth of 3500 feet. In Texas one operator is drilling a 6½-in. hole to a depth of 4250 ft. with this equipment. This type of drilling unit is used principally in fields where the average depth of wells is 3000 ft. and in which conventional rotary equipment is uneconomical.

The word "portable" when applied to these units is no misnomer. Everything needed to drill a well is carried on one truck except drill pipe, casing, fuel, and water. The 50-ft. derrick or mast folds over the truck and truck cab in traveling position. When erected it stands at the rear of the truck, to which it is hinged. Two 4½-in. x 6-in. mud pumps and high-pressure and low-pressure pumps for operating the hydraulic equipment are mounted on the truck body behind the cab. Between

View of portable rotary unit showing the auxiliary engine and drawworks mounted on truck body



View of portable unit showing mud pumps on body of truck

these pumps and the mast is the drawworks. Alongside the pumps is mounted a 4⅞-in. x 6-in., 6-cylinder, 125-hp. Diesel engine and transmission. This engine is similar to the truck engine. The use of a power takeoff makes the two engines interchangeable for drilling operations. In normal drilling the truck engine drives the rotary table and the auxiliary engine drives the mud pumps. This arrangement may be reversed or either engine may be used to drive pumps and table simultaneously. When additional power is required, as for coming out of the hole, the engines may be compounded. In an emergency the auxiliary engine could be used to power the truck over the road. The truck is a heavy-duty type and has a six-wheel drive. Power mechanism provides full differential action between all driving action, the locking control being manually operated from the cab. Air brakes are provided on all six wheels.

The drilling hydraulic equipment is built into the mast. The patented thrust head is operated by duplex pistons of 6-in. diameter and 16-ft., 10-in. stroke, powered by the high-pressure and low-pressure pumps. A downward thrust of 28,000 lb. or a lifting capacity of 56,000 lb. is available, the action being regulated by a single pressure-control valve. This makes possible control of the bit pressure at any drilling depth. The entire hydraulic-equipment frame is retractable, permitting freedom of operation while pulling and running drill pipe.

The drawworks consists of a drum capable of spooling 4500 ft. of 9/16-in. cable and a countershaft having a standard cathead on the end next the controls and an automatic cathead on the other. All operations are controlled from the driller's stand on the derrick floor.

The entire unit in traveling position weighs approximately 58,000 pounds. In some states a special permit must be obtained to travel on the highways. If the weight exceeds the limit established by state law the load is divided by disconnecting the auxiliary engine and pumps and skidding them onto another truck. When the location is reached the engine and pumps are returned to their original position and bolted in place. Less than two hours is required to change from road position to drilling position or vice versa.

Principal features of this type unit are as follows:

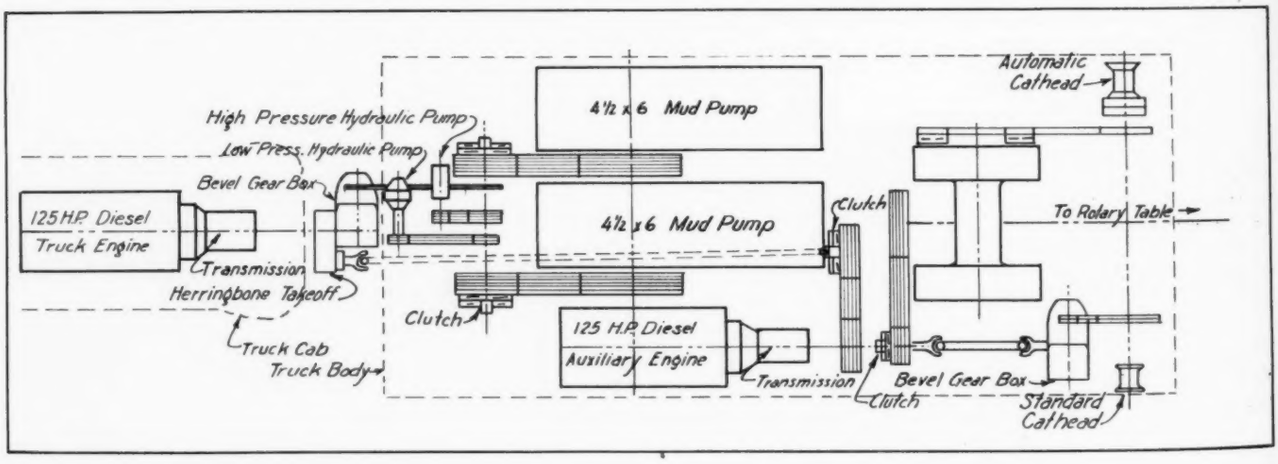
1. Low first cost.
2. Portability, and consequently lower transportation cost.
3. Speed of drilling.
4. Speed and accuracy in coring.
5. Low operating cost.

In addition to the time saved because of the increased speed of drilling, time is saved in moving from one location to another. One operator in Osage County, Oklahoma, moved such a unit one location and began drilling within three hours. In western Kansas 675-ft. wells have been completed in 24 hours. This included the time required for taking a 20-ft. core, and for erecting and dismantling the equipment.

In Barton County, Kansas, drilling to 3500 ft. cost $1.40 per foot. This figure includes charges for labor (driller and two roughnecks), fuel, grease, water, depreciation, bits, repairs, and supervision. In the Burbank area a new crew unfamiliar with the equipment drilled 2600 ft. in 13 days at less than half the previous cost for that field.

The diameter and depth of the hole that can be drilled using these units are restricted. Therefore they will not supplant drilling equipment now being used but engineers believe their use will reduce the cost of exploratory work.

Schematic diagram of complete portable unit, showing the relation of the various power units as assembled on the truck



PICTORIAL PETROLEUM

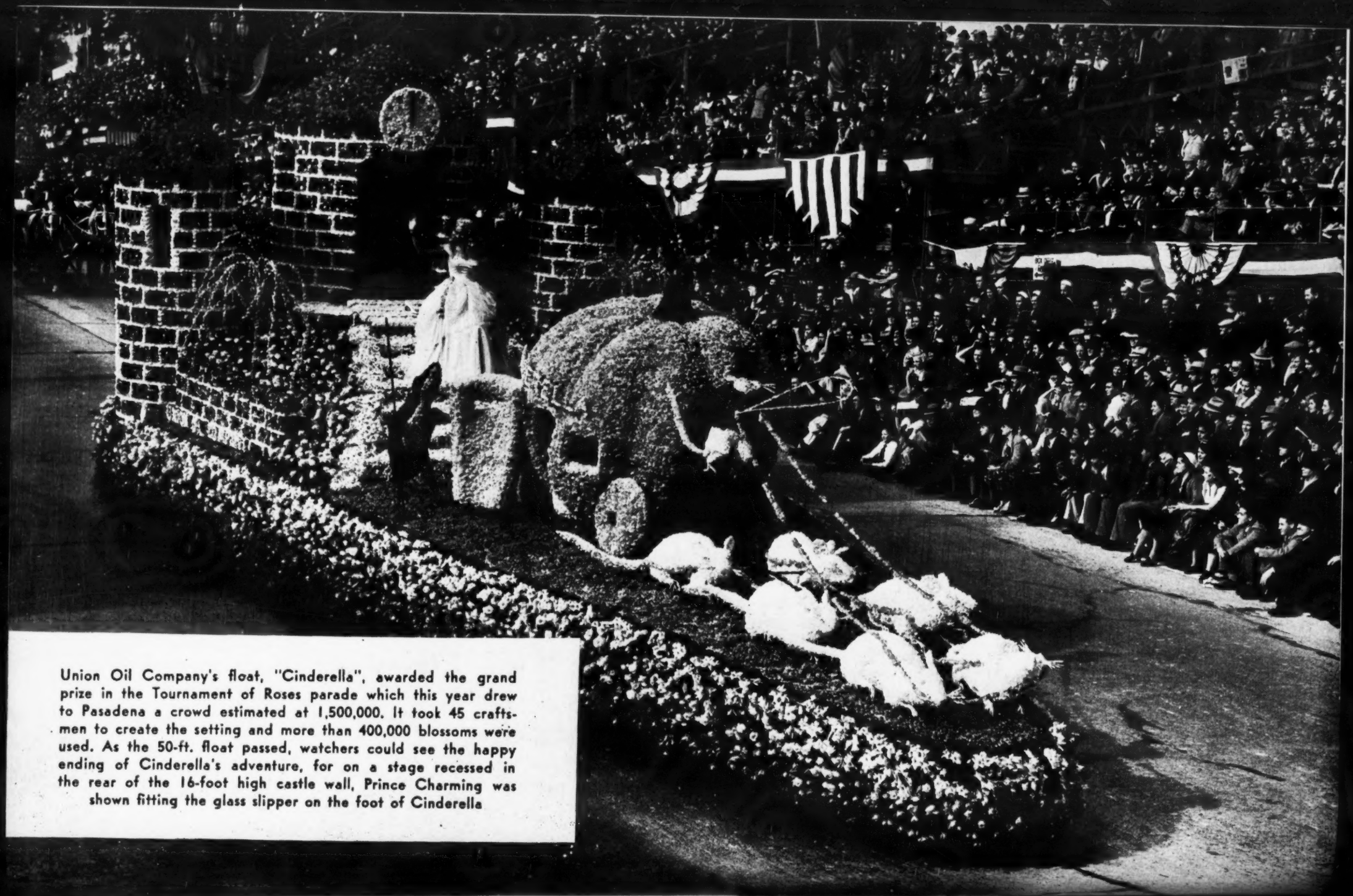
. . . A REGULAR FEATURE OF THE PETROLEUM ENGINEER

The Petroleum Engineer is desirous of having interesting photographs for the Pictorial Petroleum section, a regular feature of the magazine. We are especially interested in unusual installations incorporating advanced engineering ideas, old-time scenes and views with a foreign setting as well as portraits or good snapshots of individuals of accomplishment in the industry. We shall pay promptly upon acceptance $3.00 each for all usable photographs. Complete information for captions must be furnished.

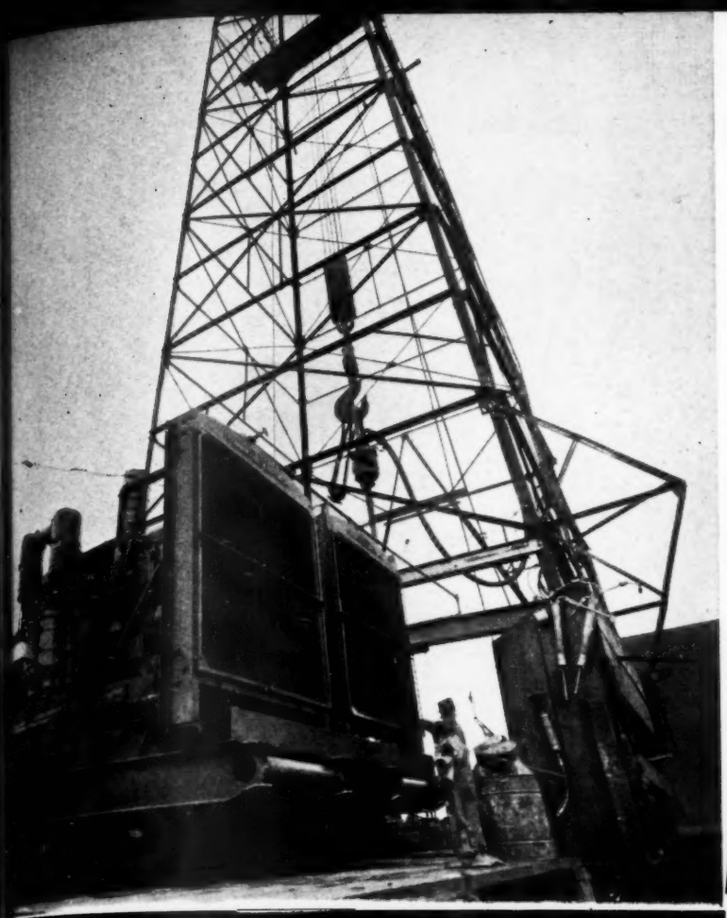
Address: THE PETROLEUM ENGINEER
Allen Building, Dallas, Texas

This photograph, taken by C. E. Burt, chief engineer, Baker Oil Tools, Inc., shows the Richfield Oil Corporation well in the El Segundo, California, field, which, it is believed, hit on December 21 a pocket of gas when about 300 ft. above the producing sand. A day later it caught fire and burned until it cratered and killed itself.

January 1938



Union Oil Company's float, "Cinderella", awarded the grand prize in the Tournament of Roses parade which this year drew to Pasadena a crowd estimated at 1,500,000. It took 45 craftsmen to create the setting and more than 400,000 blossoms were used. As the 50-ft. float passed, watchers could see the happy ending of Cinderella's adventure, for on a stage recessed in the rear of the 16-foot high castle wall, Prince Charming was shown fitting the glass slipper on the foot of Cinderella



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That's why you find Cummins Diesels delivering more than 40,000 hp. in the oil fields. That's why you find drilling contractors owning 2 to 12 Cummins Diesels each. REPEAT ORDERS TELL THE STORY.

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PIONEER IN MODERN DIESEL DEVELOPMENT

ABOVE — Dramatic nocturnal photographic study of Union Oil Company's Kernco No. 1-34 well, with which Union discovered the new Rio Bravo field, west of Bakersfield, California. The photograph was taken by the light of the torches. The character of the flat, sage brush covered terrain of the well's lonely location is shown . . . BELOW—More than 1000 lineal feet of welding was required to fabricate this absorber designed for use in treating oil. It is 8 ft. in diameter at the bottom, 7 ft. in diameter at the top, and 58 ft. 10 in. high. The 1-1/16-in. flanged steel bottom section required 10 beads of welding. The 15/16-in. flanged steel top required 8 beads in roundabout and vertical seams. The vessel has 26 flanges varying in size from 8 to 24 in. and was fabricated by Tulsa Boiler and Machinery Company with Westinghouse FlexArc welders

3 Rotary Drilling Lines that are MONEY SAVERS

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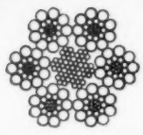
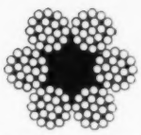
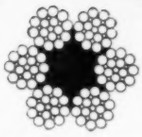


UNION 6x19 Flexible Seale Rotary Line I. W. R. C.



UNION 6x19 Filler Wire Rotary Line Hemp Center



UNION 6x16 Filler Wire Rotary Line Hemp Center

A "UNION-formed" Rotary Line is Handling a 120-ton Casing on this well

We Recommend Our UNION (pre-formed) Type

UNION engineers designed these Rotary Lines to meet the varying conditions of Rotary Drilling. The 6x19 Flexible Seale, designed for deep drilling, has drilled 25% of the wells in the Oklahoma City Field. The 6x19 Filler Wire has proved ideal for East Texas and similar conditions. The 6x16 Filler Wire was designed for Kansas and is overcoming objections found in other constructions.

UNION engineers have studied Rotary fields and can recommend the line which will prove economical for your use. For maximum service we recommend these lines in our "UNION-formed" (pre-formed) type. "UNION-formed" Lines are free from internal stresses, thus withstand greater external stress; are easier to handle; resist kinking; won't unravel when cut.

Photo shows a Tidewater-Seaboard well near Athens, Texas, being drilled by H. W. Bass Drilling Co. This 9,194-ft. well is using a "UNION-formed" line to set a 120-ton string of casing. Men in front, left to right: W. H. Brumley, Frank Denton, Z. B. Ryan, helpers. Back row: A. P. Stiles, Union Wire Rope Corp.; Dick Harris, tool pusher; J. D. Hood, driller; R. H. Coe, engineer; Jim Brooks, helper; W. Tunderburk, truck driver; S. P. Fulton, helper; J. D. Ruff, Jarecki Mfg. Co.

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UNION WIRE LINES

The "ULTIMATE LOW COST WIRE ROPE"

RIGHT — Don't be misled by the sign. This oil well has been pumping away for many years in the middle of La Cienega Boulevard, just off Beverly Boulevard, in Los Angeles. Traffic is divided by the well

BELOW

Hughes Tool Company's new store at Clay City, Illinois

BELOW — The Gulfwave, new tanker of Gulf Oil Corporation, recently launched at Sparrows Point, Maryland, plant of Bethlehem Shipbuilding Corporation. This is the 314th vessel and the 39th tanker launched at Sparrows Point. It is the third of four 11,000-deadweight ton tankers built for Gulf, the overall length being 442 feet and the molded breadth 64 feet. It will carry a cargo of approximately 3,500,00 gallons

LEFT — This well in Los Angeles is located alongside a well-traveled street. Its electric motor and entire pumping unit are totally enclosed to provide safety and prevent against tampering

RIGHT — Action scene of the new pipe line being installed by the New York State Natural Gas Corporation from its gas wells in the Woodhull Field to the main line running from Coudersport, Pennsylvania, to Syracuse, New York. The Jones & Laughlin Steel Corporation, Pittsburgh, supplied the pipe, more than 200 tons of 12¾-in. O. D. double length seamless. This was joined by Dresser couplings and is designed to carry the gas at working pressure of 500 lb. per sq. inch. BELOW—The staff of Lane-Wells Company, Los Angeles, at a Christmas party tendered to the personnel. Bill Lane is shown with package in hand. Walter Wells acted as assistant Santa Claus. Presents and cash bonuses were distributed to more than 387 Lane-Wells employees.

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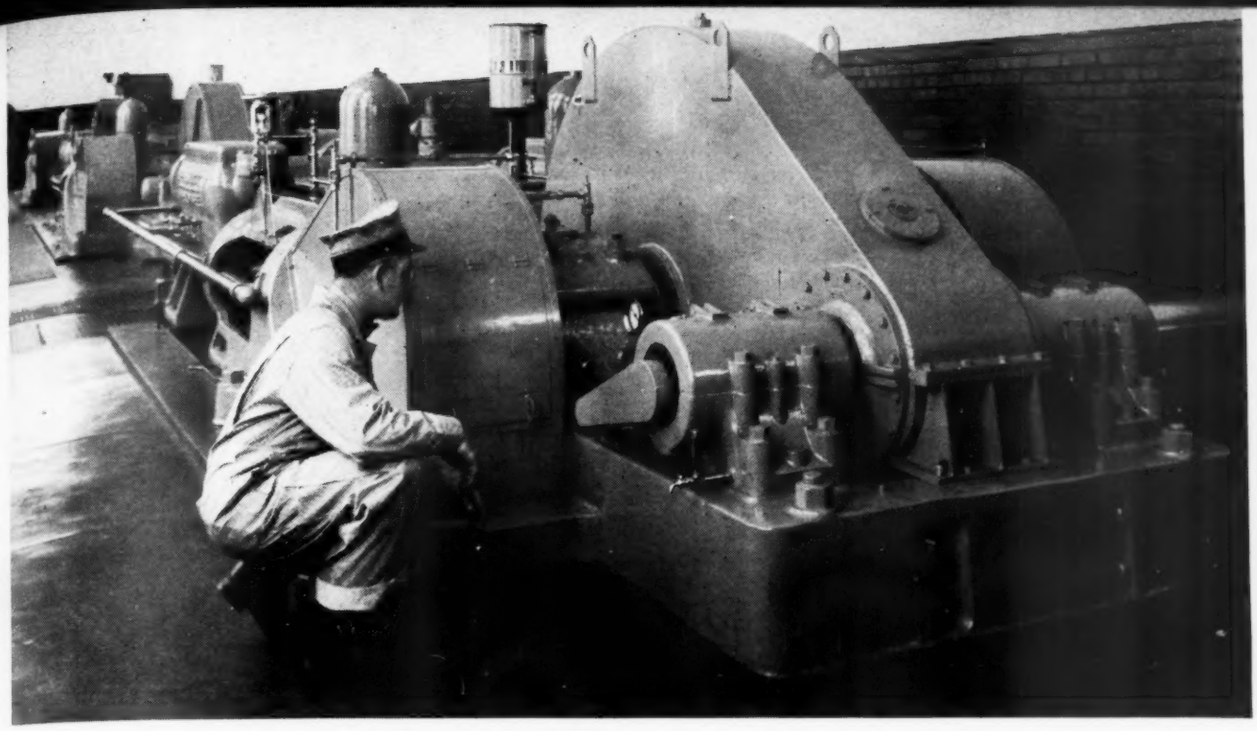


Reciprocating pump having 24-in. stroke. Note oil-tight gear case and drive to small lubricating oil pump that lubricates the gears

Additions to Gasoline Trunk Pipe Line Increase Flexibility of System

To obtain greater flexibility in transporting numerous brands of gasoline the Great Lakes Pipe Line Company has added 564 miles of pipe line, and installed more pumping units and certain auxiliary equipment at its existing stations.

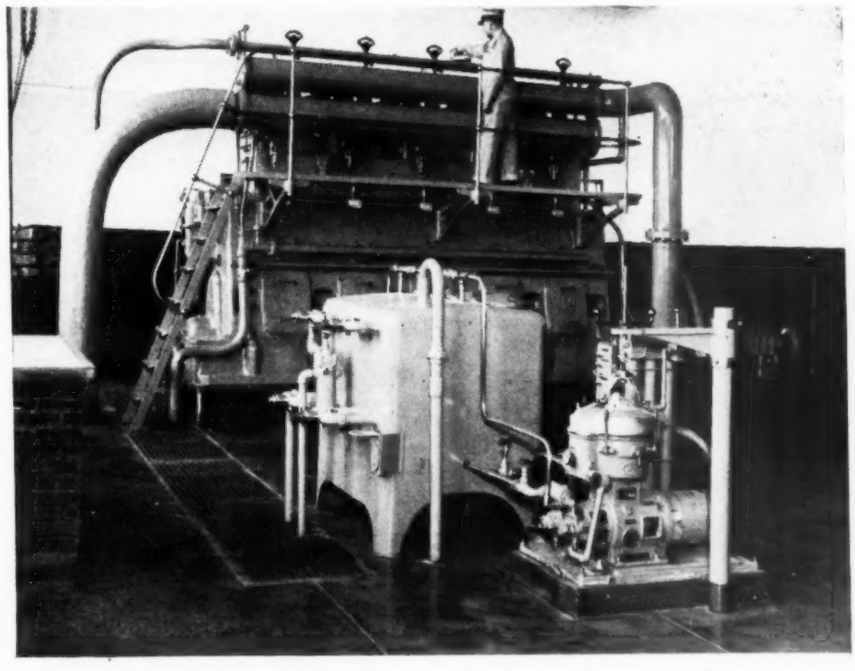
By FRANK H. LOVE

THE Great Lakes Pipe Line Company recently completed the laying of 564 miles of pipe line, which either replaced or paralleled existing lines in order to increase flexibility in transporting the numerous brands of gasoline through its system.

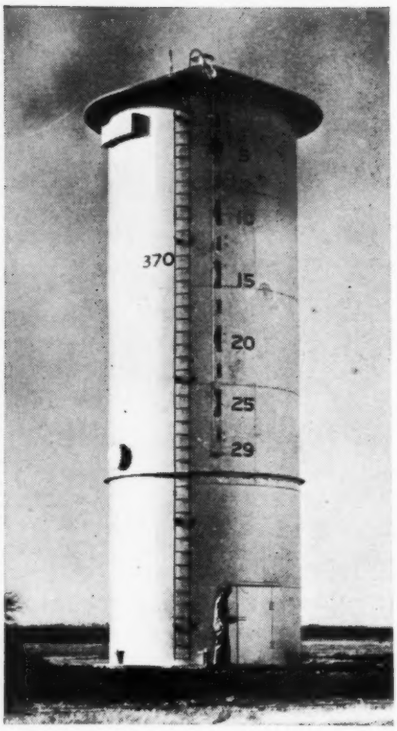
A part of the construction work consisted of replacement of 4-in. pipe in the line between Osceola and Council Bluffs, Iowa, with 6-in. pipe, and the abandonment of booster stations at Afton and Macedonia, Iowa. The change previously had been anticipated and necessitated no additional pumping units at the primary stations.

The program included construction of an 8-in. line parallel to the line between Barnsdall, Oklahoma, and Kansas City, Kansas. Single pumping units, installed at Barnsdall, Oklahoma, and Humboldt, Kansas, consist of a 5-cylinder, 15-in. by 18½-in., 270-r.p.m., solid-injection Diesel engine, direct-connected to a 6-in. by 24-in., 4-plunger, single-acting, reciprocating pipe-line pump.

To complete the construction program a 6-in. line was laid paralleling the line between Des Moines, Iowa,



Newly-installed 5-cylinder, 15-in. by 18½-in., 270-r.p.m. Diesel engine in background. In foreground, centrifuge and lubricating oil tanks



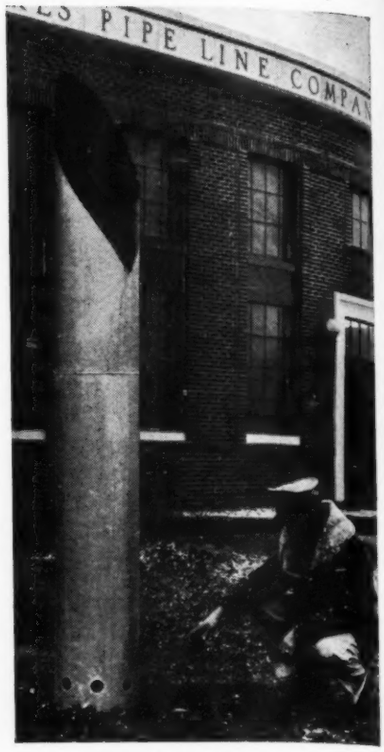
Surge tank on pump suction line

and St. Paul and Minneapolis, Minnesota. At Des Moines, Iowa, two 150-hp. synchronous motor-driven 4¾-in. by 18-in., 4-plunger, single-acting pumps were installed. One pump acts as a standby for all units operating at this station. At the midway point, the Alexander, Iowa, station, one pumping unit was installed, consisting of a 3-cylinder, 13-in. by 17-in., 300-r.p.m., solid-injection Diesel engine direct-connected to a 4¾-in. by 18-in., 4-plunger, single-acting reciprocating pipe-line pump. The design of the motor-driven pumping unit extension at Des Moines varied from the original design only in the size of the motor room, which was made smaller and houses only the motor and motor-starting equipment, whereas the building as originally designed was sufficiently large to house the Diesel engines that were first contemplated.

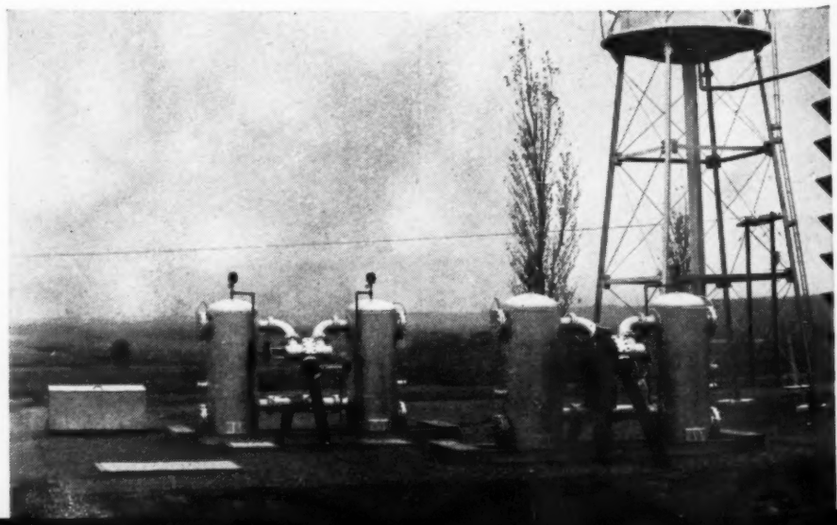
Des Moines station, showing extension to building necessitated by installation of motor-driven equipment

No additional auxiliary equipment was required except a lubricating oil centrifuge, which will also purify oil for the next added unit. It is situated midway between two units and arranged for continuous operation in series with the engine operating system, or for batch purification of the oil in the storage compartments. The purifier is driven by a 1-hp., d-c. motor. Its capacity is 150 gal. of oil an hour; the sediment capacity is 84 cu. inches. It has a self-contained three-stack, 9-kw. heating element for maintaining the temperature of the lubricating oil at 180 deg. fahr., if necessary, and making it possible to vary the heat input according to the temperature of the incoming oil. Each engine has a double-compartment lube tank connected with the engine lubricating system through three-way port valves. The three-way port valves have wide outlet ports so that the system is never starved for oil. Cleaning of the centrifuge is facilitated by use of a service cart and a screw hoist for handling the bowls. The cart has a recessed top, beneath which is a covered sump and a rack for the cleaning tools. The sump is concealed in a drawer and is easily removed and carried to the station incinerator.

As the Humboldt, Kansas, and Alexander, Iowa, stations are midway points patented duplex tank-type strainers have been installed on the incoming lines. These strainers are connected to a manifold valve, the stream



Air-cooled exhaust stack

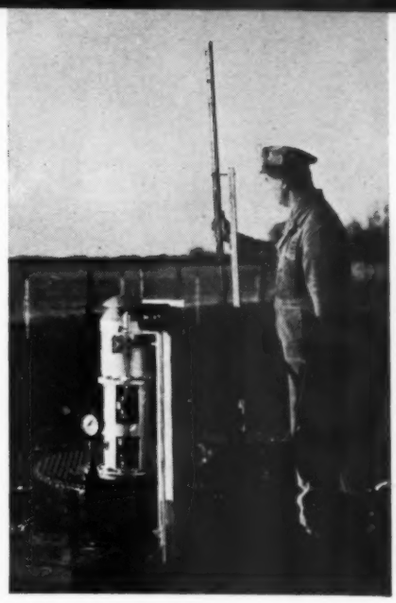


Duplex strainers on incoming lines Nos. 1 and 2

entering the bottom of either strainer, where the velocity of flow is reduced to approximately one-half ft. a second. The flow continues upward, passing through excelsior, thence through a screened outlet connection to the suction lines of the pump. The reduced rate of flow results in trapping a large part of the pipe-line accumulation and water in the bottom of the strainer. The remainder is "knocked out" by the excelsior.

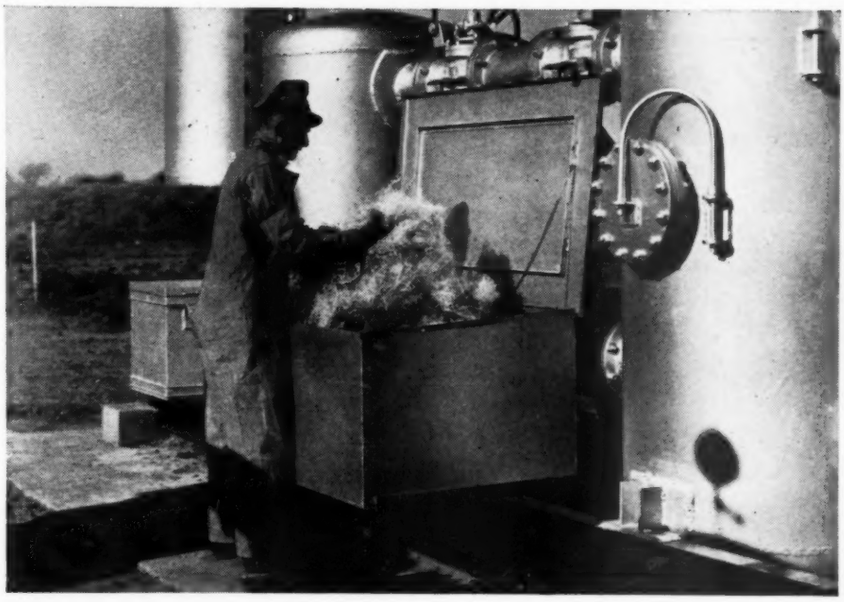
During normal operations all foreign material and some gasoline are drawn off through a drain to an enclosed separator, from which point the water and gasoline pass to an enclosed sump tank equipped with a swing-line pump suction, so that the water can be pumped to a burn pit and the gasoline pumped back into the gasoline stream. Debris is shoveled from the separator.

To receive a scraper while these strainers are in operation it is necessary that the differential pressure-control valve be partly closed and a small valve in the return line from the scraper trap open. This arrangement allows the scraper to enter the scraper trap. The trap valve and the small valve are then closed, permitting the removal of the scraper. Either strainer can be cleaned without interrupting the flow or station operation. Tests of these strainers in operation show that there is a negligible pressure drop through them, and that all material larger than 200 mesh is removed.



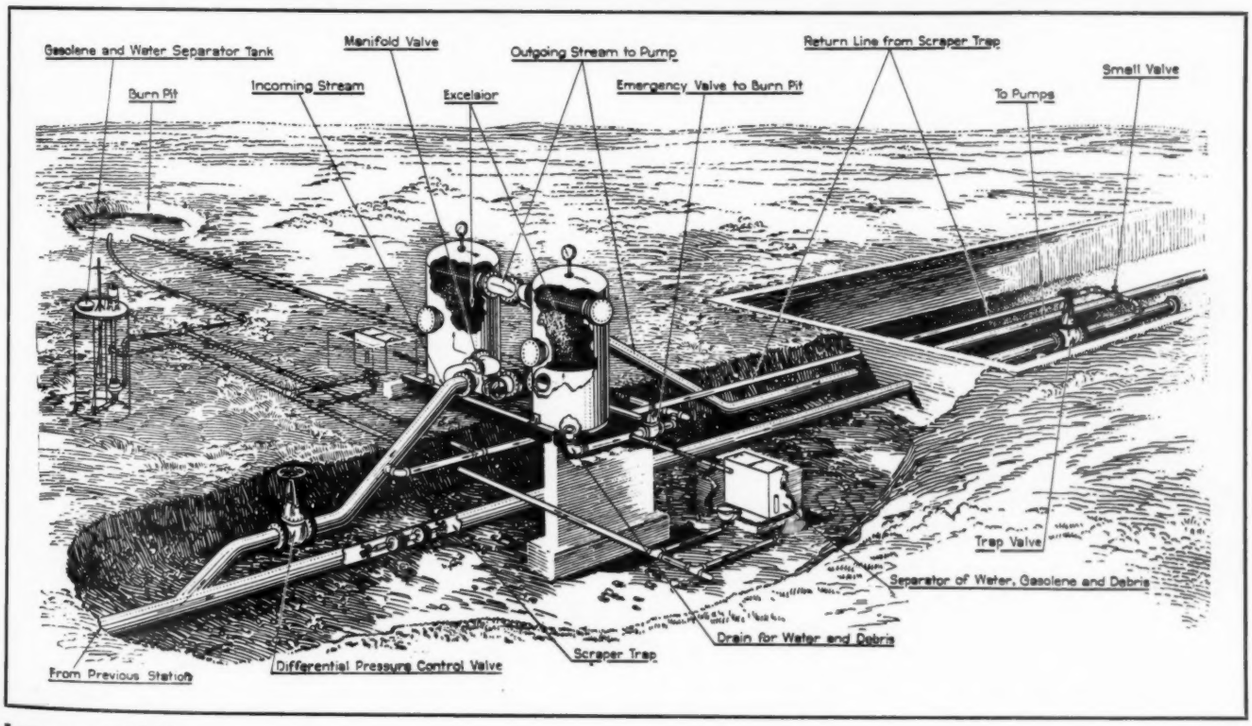
Sump tank and sump pump, equipped with swing line suction pipe

Surge tanks were installed at the Humboldt, Kansas, and the Alexander, Iowa, stations. These surge tanks are 16 ft. in diameter and 40 ft. high. The bottom of the tank is elevated 14 ft. from the base. The primary function of this surge tank is to permit, by reason of its small capacity, a quick pumping-out prior to the change of grade of gasoline, thus reducing the interval during which the pump suction does not draw on open storage.



Right—Duplex strainers, showing excelsior for packing upper compartment of each

Below—Typical arrangement of duplex strainers on incoming line to station



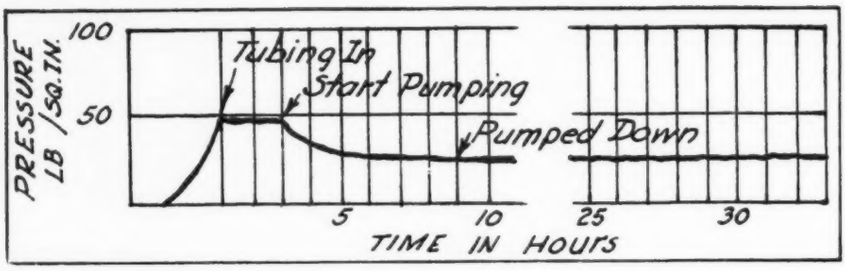


Fig. 1. Sub-surface pressure in pumping well

Fluid Level as a Guide to Pumping Efficiency

Locating the fluid level is an inexpensive procedure that may effect appreciable savings by indicating the proper reconditioning method

By WALLACE A. SAWDON
Petroleum Engineer, Los Angeles

MOST wells now on the pump are probably operated for the purpose of obtaining maximum production. If the hole is kept in good condition and if proper equipment is installed there should be no reason why the well cannot be kept pumped down and maximum flow of oil into the hole maintained. Such results, however, are not always obtained; and although only minor adjustments may be necessary in order to obtain maximum production, an analysis of subsurface conditions that would indicate clearly the need for such adjustments is not always available. The height of the fluid level above the intake of the pump during actual pumping operations is certainly an index to the efficiency of the operation; and ascertainment of the fluid level provides valuable information necessary before corrective measures can be taken.

The use of fluid level data for the purpose of obtaining maximum production is not the only application of such data, as in many wells pumping involves other problems than that of getting all the oil a sand can produce. The height of the fluid level is an index of the pressure on the sand at a certain datum and the differential pressure across the face of the sand at that datum. Whether demand requires that the maximum amount of oil be produced or the formation characteristics make advisable the maintenance of a back-pressure on the sand, the pump can be set at the proper depth to obtain the desired results or the rate of production so controlled that maintenance of the proper fluid head above the formation will be assured.

Bottom-hole pressure bombs or gauges have been used extensively during the last few years to determine whether or not a well is being pumped off. The pressure at any depth is a function of the height of the column of fluid above that depth, and may be used to determine the height of the column, assuming that all factors such as fluid density, casing gas pressure, etc., are taken into consideration in making the computation. In evaluating production possibilities, however, the pressure itself is used to determine directly the differential pressure at the depth at which the pressure measurement is made. The value of such pressure measurements as a means of determining pumping efficiency is indicated by the following statement of Millikan and Sidwell.[1]

"Bottom-hole pressures have been taken in pumping wells under operating conditions by placing the gauge in a perforated anchor below the standing valve. The chart obtained in one of these wells is reproduced in Fig. 1. This well had been shut down for over 24 hr. at the time this chart started and the pressure recorded was 53 lb. which is considered as the formation pressure. After pumping 5 hr. the pressure decreased to 30 lb., which is 66

[1] "Bottom-hole Pressures in Oil Wells" by C. V. Millikan and Carroll V. Sidwell, presented at the Tulsa meeting of the A.I.M.E., October, 1930.

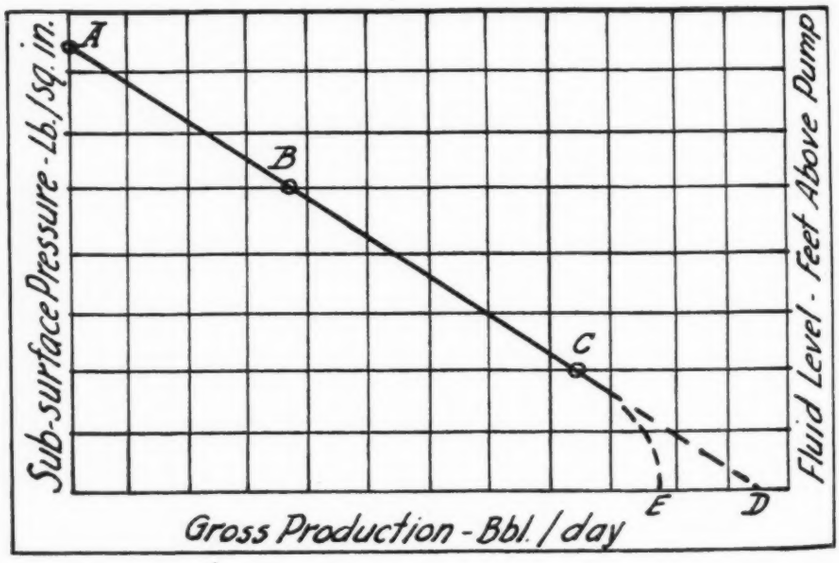


Fig. 2. Pressure-gross rate curve

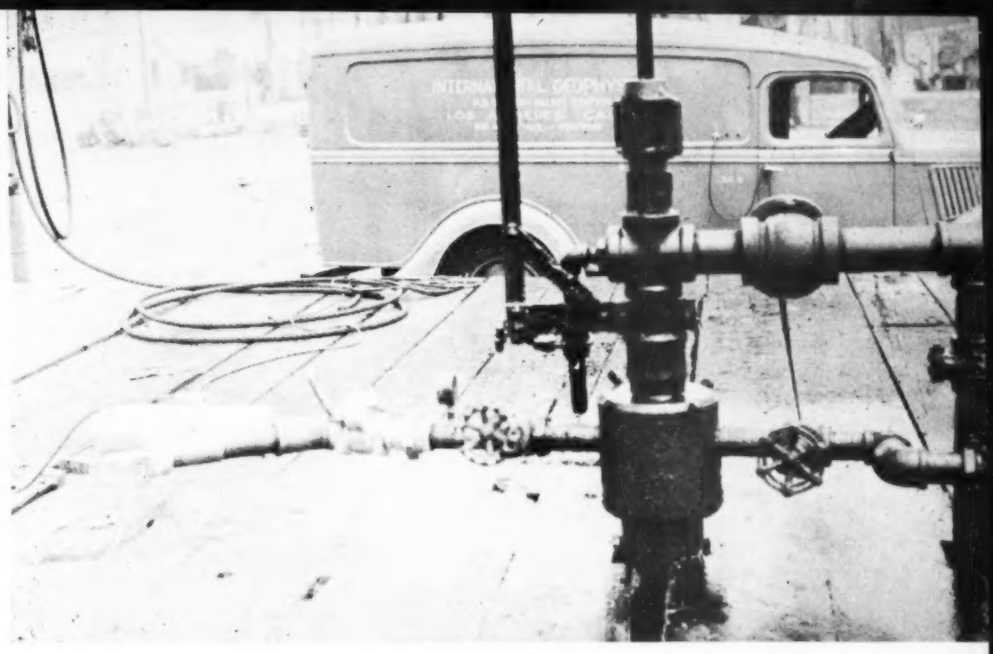


Fig. 3. The I.G.I. fluid level locating equipment installed at a well

percent of the formation pressure (absolute). The pressure did not change during the rest of the period of the chart (33 hr.). During this time production averaged 16 bbl. per hour. Another well had a formation pressure of 69 lb. and pumped 27½ bbl. per hour, with a bottom-hole pressure of 56 lb., which is 84 percent of the formation pressure (absolute). It is probable that the amount of oil pumped from each of these wells was limited by the capacity of the pump, and it is unlikely that the maximum amount of oil was delivered to either well with so low a differential pressure in the formation. A knowledge of bottom-hole pressures in pumping wells will give as much information for solving recovery problems as in flowing wells. It will also show whether the rate of production obtained is limited by the capacity of the pump or by the capacity of the sand to deliver oil to the well."

From experience gained since the paragraph above was written it can be stated definitely that the maximum amount of oil was not being delivered to either of the wells cited.

In determining the capacity of a well to produce, the productivity index is being used by many companies to show the relationship between the sub-surface pressures and production rates. The definition of "productivity index" is given by Kantzer and Trostell[2] as "the barrels per day of gross liquid produced per pound per square inch pressure drop at a specified subsurface datum." This is expressed in the following formula:

$I_d = R_g$ per lb. per sq. in.

where:

I = productivity index

d = datum in ft. of depth

R_g = gross production rate

"In pumping wells, where the producing fluid level is below the top of the perforations, mean pressures are preferred to datum pressures. The productivity index as defined above is useful only when the pressure-gross rate curve is linear, or substantially so, and its use should be restricted to this condition. Often this curve is not linear; and in such cases the productivity index, if one were to call it by that name, would be variable with the rate of production and, if stated, would need to be qualified for the given rate at which it is determined. Linearity in pressure-gross rate curves has been observed under widely varient conditions, but it has been observed that this condition occurs most commonly where formation free gas-oil ratios are low and where wells are in the latter stages of production."

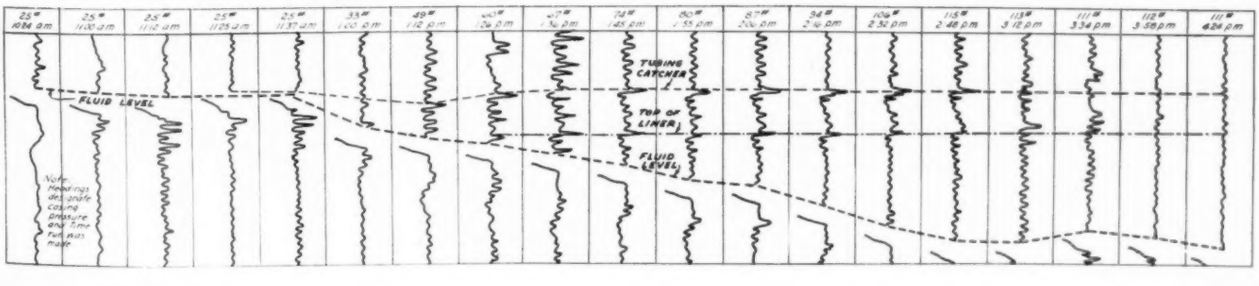
An arbitrary pressure-gross rate curve is given in Fig. 2. The abscissas indicate the gross production in bbl. per day. The general practice has been to represent the bottom-hole pressures as ordinates, as shown on the graph. When fluid levels are determined at periodic intervals, however, a curve could be laid off representing the fluid level in ft. above the pump intake as the ordinate. Although it is not recommended that a productivity index expressed in gross bbl. per day per ft. of fluid be regarded as an accurate expression of a well's capacity to produce, the results obtained from the application of fluid level data in deriving such an index might be surprisingly accurate.

In laying out the pressure-gross rate curve, any two points such as A and B, A and C, or B and C can be used. If the well is shut in, the point A is used. If such shut-in pressures are difficult to obtain, the pressures or fluid levels at two rates of production will provide the points B and C. It has been found that in most of the pumping wells investigated the pressure-gross rate curves form a comparatively straight line. Some graphs curve sharply downward (as toward E in Fig. 2) when the fluid level approaches the pump intake. In some, however, the line continues straight to the point D where the fluid is pumped off completely.

The use of bottom-hole pressures probably is the most nearly accurate method of determining proper production control. The periodic taking of such pressures under changing well conditions, however, interferes with production and consumes considerable time. The pressure bomb or gauge is run in an anchor below the standing valve. Although readings covering periods up to 72 hours during which the well is pumping are now being taken, it is necessary to pull the pump (also the tubing in many wells) both when running the bomb into the well and when removing it.

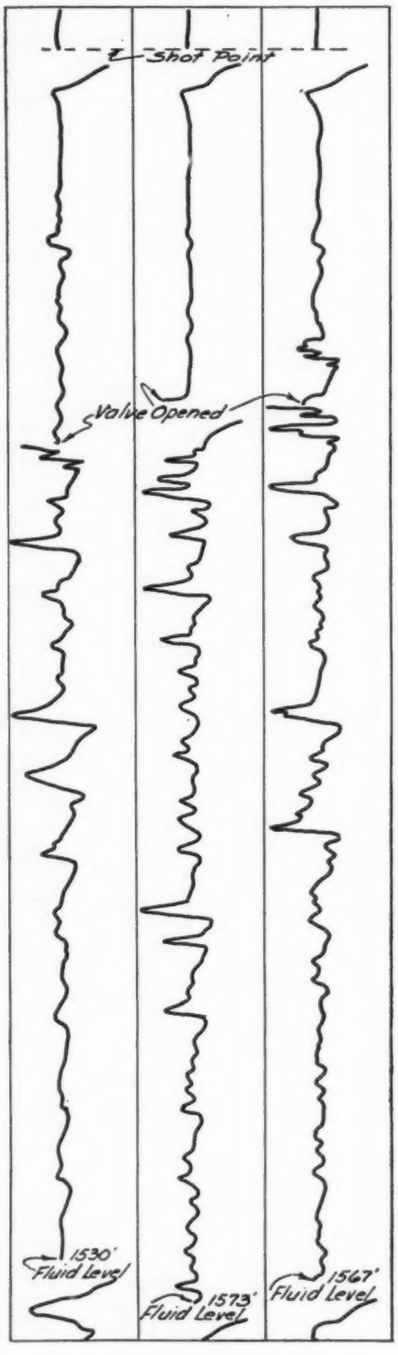
[2] "Oil-Well Performance: A Discussion and Proposed Terminology" by B. P. Kantzer and E. G. Trostell, presented at the Eighteenth Annual Meeting, A.P.I., Chicago, November, 1937.

Fig. 5. Here is shown how the fluid level varies inversely with the pressure at the casinghead of the well



With the devices now available fluid levels can be determined without shutting down the pump or interfering with production in any way. The process itself requires but little time and the results show the depth of fluid within very close limits and also the physical height of the fluid column during pumping operations; however, it does not measure the factors affecting pressures, which must be considered if bottom-hole pressures are to be used to determine possible productivity.

Fig. 6. Three runs made in a well while producing under vacuum



Fluid level conditions brought out in the following discussion and graphs were determined by equipment recently developed by International Geophysics Incorporated under the technical direction of Dr. J. J. Jakosky. The laboratory and development work were conducted by Dr. D. D. Taylor and the field tests herein discussed were made by Kenneth R. Walker.

The fluid level is found by recording photographically on a strip of moving film the electrical impulses caused by sound waves generated by the discharge of a cartridge at the surface. The sound passes down the well in the annular space between the tubing and the casing and is reflected by the tubing joints, tubing anchors, top of liner, change in casing size, or any other irregularity until the fluid level is reached. The major reflection registered, of course, is that from the surface of the fluid.

The equipment employed in this method of locating fluid level is shown in Fig. 3 as installed at a well ready for operation. That part not housed in the truck is connected to the casinghead through a valve. The gauge for indicating casing pressure provides data on the pressure being carried between the casing and the tubing. Beyond the gauge can be seen the cartridge inserted in a "Y" in front of a lever-operated valve. This valve remains closed until the shot is fired in order to shield the special electric detecting device, shown to the left of the valve, from the effect of the detonation. Between the cartridge and the casinghead is a flame arrester similar to the type used in mines.

The firing of the cartridge is controlled electrically from the truck. A 4-conductor, $\frac{5}{16}$-in. O.D. rubber-covered cable connects both the detonator and the electrical detector with the control panel in the truck. The rest of the apparatus is contained in the truck, no equipment being placed on the derrick floor. The entire operation, including exposure and developing of the film, is conducted in the truck and the results giving the location of fluid level are available before the truck leaves the well. It takes approximately five minutes to hook up and get ready for the shot. During the procedure the pump is not shut down and production of the well continues without interruption. The electrical design is such that well noises resulting from the pumping operation or other causes are filtered out and the record of the shot reflections is not distorted.

The lever valve is closed before the cartridge is discharged, in order to protect the electrical detecting device. The valve is then opened immediately, al-

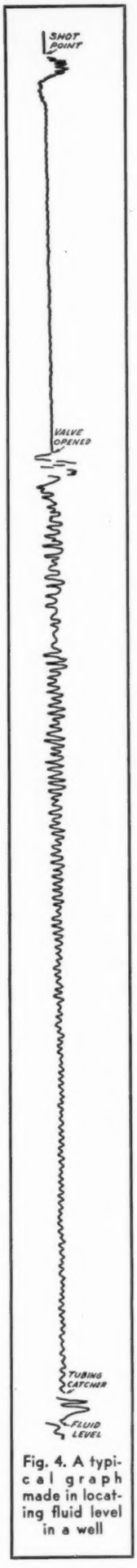


Fig. 4. A typical graph made in locating fluid level in a well

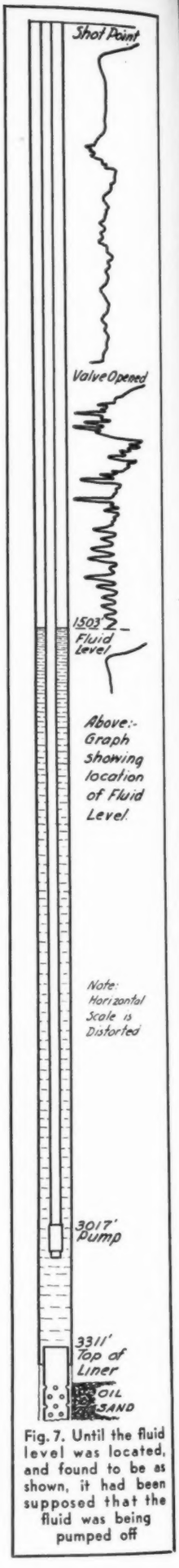


Fig. 7. Until the fluid level was located, and found to be as shown, it had been supposed that the fluid was being pumped off

lowing the recording of all reflections as the sound wave passes down the well (Fig. 4). Each of the small jogs in the oscillograph indicates a tubing collar and in this record of a well in which the fluid level is below the tubing catcher the reflection from the tubing catcher provides a check on the computation of the fluid level.

Accuracy is achieved by the use of a steep wave front sonic measuring device. By using this very steep wave front the time interval between the initiation of the sound disturbance and the receipt of the reflection is accurately measured. In addition, the steep wave front shows clearly the minor reflections caused by the tubing collars and other constrictions in the well. The method is effective in wells producing under a partial vacuum or under high gas pressure.

The film on which the record is made is driven at a constant speed. Athough the velocity of sound through the gaseous medium above the fluid has been found to vary from 900 to 1400 ft. a second in wells in a single area such as the Los Angeles Basin of California, the speed through the gas in any certain well remains essentially constant for the entire depth of the well. If the average length tubing joint used in the well is known, the reflections from tubing joints provide a scale that can be used to compute the distance to the fluid.

Tubing catchers, the top of a liner, and other points of known distance below the surface provide reflections that serve to check the computations. In a Playa Del Rey well, the record from which is shown in Fig. 4, the tubing catcher was a definite marker and was used to verify the calculations based on tubing collar reflections.

The effect of change in the casing pressure during pumping operations is shown in Fig. 5. In this series of runs made in a well in the Dominguez field the fluid level at first was just above the tubing catcher and only tubing collars and the top of the fluid were recorded. As the fluid level was lowered the tubing catcher was indicated, and, as the fluid level dropped still farther, the top of the liner reflected the sound waves. The close relationship of the casing pressure to the fluid level is clearly evident in the last five readings, which indicate that the fluid level varied inversely with pressure.

Another application of the fluid level measurement is shown in Fig. 6. A well in the Santa Fe Springs field was producing under partial vacuum and it was believed that there could be no fluid column above the pump. The production was disappointing, however, so a run was made to locate the fluid level and to determine whether the pump was handling the production as it should. Although the pump was set at 3816 ft. the fluid level varied between 1530 and 1573 feet.

From another well in the Santa Fe Springs field, the record from which is shown in Fig. 7, it was desired to produce the maximum volume of oil. Two runs were made to locate the fluid level and, although the pump was set at 3017 ft., the fluid level could not be lowered below 1503 feet. The pump quite evidently did not have sufficient capacity.

The location of the fluid level in a well while it is off production will indicate definitely whether or not enough fluid is coming into the hole. Remedial action will depend on the conditions disclosed, and due consideration should be given to the possibility of insufficient pump capacity, the possibility of gas locking, and any other factors that may interfere with removal of all fluid entering the well.

A low fluid level will show that what oil enters the well is being pumped off. The necessity for cleaning out or making other repairs will then be apparent. Before pulling the pump it may be wise first to locate the fluid level. To do so may reveal an unsuspected source of trouble and may save a costly job of pulling rods and tubing.

If proration is based on bottom-hole pressure measurements, the determination of the fluid level offers a convenient and easy way of obtaining the necessary data.

The experience of companies using fluid level devices indicates that the fluid level determination gives a reliable guide to pumping operations at low cost and without interfering with production.

A preliminary fluid level determination can be ready within 15 or 20 minutes after the truck reaches the well.

The fluid level determination for a single average well including measurements at the well, interpretation of records, submission of reports, mileage, and incidental expenses, will probably cost less than $35. If there is a series of wells in the same area to be tested, the cost per well will be reduced materially. Compare this with the cost of pulling and running rods and tubing, the shutdown time during such operations, and loss of oil and gas production while the well is shut down.

Electrical and Mechanical Properties of Cables Improved

INVESTIGATIONS of the processes used in the manufacture of different types of cable, and of the properties of the materials used, led to decided improvements in electrical and mechanical properties of cables, and to the opening of new fields of applications for them, says Guy Bartlett, of the General Electric Company, in writing of developments in the electrical industry during 1937. For example, in tellurium-compound cable jackets, for use where abrasion is severe and toughness is required, the tensile strength, modulus, and tear resistance were all further increased. Coronol, a corona-resisting compound, was applied to larger conductor sizes, for higher voltages, and in longer lengths.

A new paper-insulating machine was developed and installed. This machine is equipped with special devices to prevent buckling or wrinkling of tapes, and to control tension.

A similar machine is being installed for applying varnished-cambric insulation, with the difference that there are only two taping heads per stand instead of four to allow for the use of compound between the tapes as required in this type of insulation.

A new lead pot designed for the lead press completely protects the hot metal against oxidation. This does not supersede the hydrogen process, but rather supplements it.

New equipment has been developed for shipping very long lengths of cable for submarine or buried service. As a result, a 3750-ft. length of three-conductor cable weighing 44 tons can be readily handled.

As regards cable accessories, a new oil-resisting compound developed for use in solid cable joints has an oil solubility in service that is practically negligible. Also, it is free from black asphalt, which, when dissolved in cable oil and compound, tends to contaminate them somewhat.

Equipment for the pressure-attachment of insulated cable connectors has been developed. Connector-to-conductor attachments now can be made quickly and entirely satisfactorily without the customary soldering operations that might endanger the oil and solid insulation.

Recent Advances in Knowledge of the Colloidal Properties of Clay Suspensions and Gels[a]

Part 1

By CHARLES E. REED[b]

Investigations relating to drilling muds cover a broad field of research. This paper is an important and timely contribution to the literature on this subject, because it presents the theories that guide the efforts of the experimenters and form the basis for interpreting the results of current research on the properties of rotary drilling mud. Although all the laws governing the behavior of clay suspensions and gels have not been evolved, enough knowledge has been gained that investigations can be planned intelligently and pursued systematically.

—The Editor.

WITH the increasing importance of clay in drilling operations, which demand more precise and exacting control over its behavior, there has come the realization that most of our present methods of control over many of its important properties still represent more of an art than a science. Such a situation with respect to a material of such industrial significance is unfortunate, and naturally many investigations have been conducted to improve our knowledge. In general, these investigations have revealed the complex nature of clay behavior and while sometimes they may not have seemed to contribute directly to a solution of the field operator's problems they have been of inestimable importance in bringing to light the broad fundamental scientific principles upon which must be based any effective working theory correlating the known facts of clay behavior and predicting profitable new lines of attack for its improvement.

Major Facts Concerning Behavior of Clays

In the study of clays, as in that of most other colloidal materials, it has been impossible to make progress by the study of isolated facts. On the other hand, analysis of large groups of facts, many of which seem at first completely unrelated, can lead to a deeper insight into the structure of clays and the mechanism of their behavior. It will be well to list the major facts on which the analysis here presented is based, starting with those that have emerged repeatedly from past investigations and which thereby constitute an impregnable foundation upon which must rest any comprehensive theory of clay behavior:

1. Clays consist of hydrated aluminosilicates of extremely fine and variable particle size.

2. Suspended in water, clays exhibit variable degrees of swelling, depending upon their origin and upon the chemical and colloidal nature of any other substances present. The magnitude of the swelling is a direct indication of the extent to which the clay has become dispersed.

3. Associated with any given natural clay is always found a definite quantity of dissociable metals, usually alkaline or alkaline-earth cations. These cations are readily replaceable by each other and by hydrogen; a clay may be saturated with any metallic cation by repeated treatment with a solution of the corresponding neutral salt or hydroxide in the case of a metal, or acid in the case of hydrogen.

4. Purification of clay from replaceable metals may be effected by dialysis. In this process the water dispersion of clay is enclosed within a membrane having pores large enough to allow free passage of the ions across it to distilled water without, where they are washed away. The clay particles are too large to pass through the pores of the membrane and they remain behind where hydrogen ions from the water replace the cations that have been removed.

5. The viscosity of clay suspensions is always markedly greater than that of water alone and, like swelling, varies widely with the chemical and colloidal nature of any other substances present. This increased viscosity must be due to the interference of the suspended particles of clay with normal flow of the suspending liquid.

6. Under proper, but widely variable, conditions of concentration of clay and electrolyte present it is possible to obtain a clay gel that possesses a yield point necessitating a finite distorting force to make it flow as contrasted to a suspension, which, like a true liquid, will flow under a differential distorting force.

7. Examined under the ultramicroscope the individual clay particles in a fluid suspension (sol) exhibit violent Brownian motion, while those in a gel are still distinct, but motionless. Without question the formation of a gel with its yield point and greatly increased viscosity has come from some type of structure built up within the liquid as a result of the suspended particles becoming locked into fixed positions, although, as will be seen later, the mechanism by which this locking takes place is questionable.[c]

[a]Paper presented at Oklahoma City meeting, Petroleum Division, American Institute of Mining and Metallurgical Engineers, October, 1937.

[b]Department of Chemical Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts.

[c]The occurrence of structure in a suspension of particles implies that a finite force is necessary to change the position of any one particle with respect to the other particles. Under such conditions the supension of particles is said to constitute a gel as contrasted to a sol, a suspension in which each particle may be freely moved about by application of only a differential distorting force. Many types of structure may be imagined to exist within a gel and gels of different substances may have widely differing types of structure.

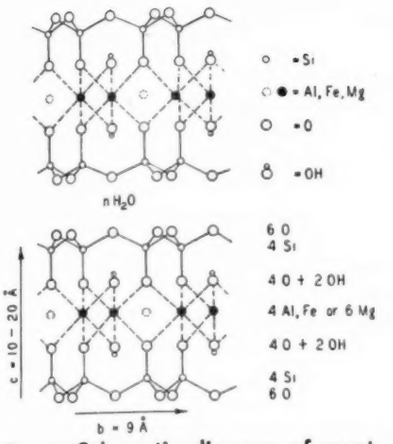


Fig. 1. Schematic diagram of montmorillonite H_2O. (Al_2O_3, Fe_2O_3, 3MgO) $4SiO_2 + nH_2O$

8. Very often the particles are locked into place only loosely, as it is possible by relatively weak mechanical agitation to destroy the gel structure and produce a sol, which, if allowed to stand undisturbed, will increase in viscosity and reset to a gel. Such systems are called thixotropic in the literature.

9. The viscosity of a clay suspension is a much more complex quantity than that of a true liquid, where it is a constant equal to the shearing stress divided by the rate of shear. If, by analogy to a liquid, the viscosity of a suspension be defined as the ratio of shearing stress to rate of shear, this quantity is not a constant but is some complex function not only of the rate of shear itself but also of the time and the past history of the suspension, the latter manifesting itself as thixotropic behavior. Therefore, whenever viscosities of clay suspensions are reported they are meaningless unless accompanied by a detailed description of the exact conditions of measurement.

Relevant Facts from Recent Investigations

It must be repeatedly emphasized that the only difference between clay suspensions and gels that has been discovered to date is a mechanical difference, the gel possessing a yield point and a higher viscosity. From the standpoint of the production engineer, it is just these mechanical differences that are most vital, for they must affect directly such important properties of a drilling mud as its ability to suspend and be freed from cuttings, its ease of circulation and settling characteristics, and its retention of gas bubbles.

As the relatively high viscosity of clay sols is due to interference of the constituent particles with flow and as the yield point of clay gels is due to these same particles forming a structure it is clear that particle structure, shape, and size will exert a tremendous influence upon all the important mechanical properties mentioned above. Our knowledge of all these properties, formerly highly speculative, has undergone great strides as a result of recent investigations.

Particle Structure and Shape

Clays of industrial importance may be divided into two main groups—the kaolinite group having the empirical formula $Al_2O_3.2SiO_2.2H_2O$ and the montmorillonite group having the empirical formula $Al_2O_3.4SiO_2.H_2O$. It has been shown from X-ray data that the crystal lattice of both groups is of the layer type consisting of superimposed planes of aluminum and silicon bound together through oxygen bridges.[13*]

Fig. 1 shows a schematic diagram of the structure of montmorillonite, the chief clay mineral in bentonite.[8, 9] Each group of planes consisting of two layers of silicon atoms bound to one layer of aluminum atoms through planes of oxygen atoms can extend indefinitely in the *b* direction as shown on the diagram and in the *a* direction perpendicular to the diagram. Such a group of planes, hereafter referred to as a crystallite, is composed of an indefinite number of unit cells—the smallest units in the crystal that repeat themselves. The clay particle may consist of but one crystallite or an indefinite number of crystallites stacked on top of each other like a pack of cards and held together by residual surface forces. The structure shown in Fig. 1 indicates that individual clay particles have great strength and that they might readily form the rigid, platelike particles with enormous ratios of length to thickness, as previously postulated.[19, 11]

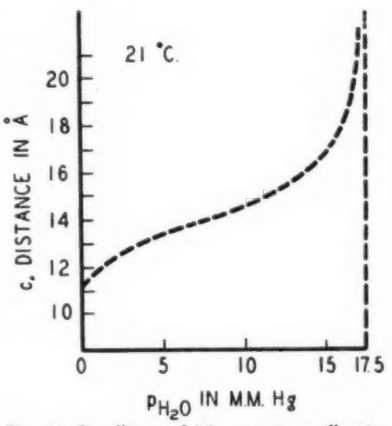


Fig. 2. Swelling of Na montmorillonite

Fig. 1 also illustrates that the clay minerals are in general of widely variable compositions and isomorphous structure, it being possible in this case for iron and magnesium to replace aluminum.

An insight into the origin of the swelling properties of bentonite muds may be obtained by examination of Figs. 1 and 2. When bentonite is dry the individual crystallites are bound closely to one another and the distance in the *c* direction from any plane in one crystallite to the corresponding plane in an adjacent crystallite is about 11 Å. (1 Å. $= 10^{-8}$ cm.). When water is added to the bentonite in increasing amounts, the water molecules migrate in between adjacent crystallites and pry them farther and farther apart.

Hofman and Bilke have watched this process take place under the X-ray and have measured how the distance between corresponding atoms in adjacent crystallites increases with water content of the clay. Fig. 3 shows that as the vapor pressure of H_2O over the clay increases from 0 to 17 mm. Hg, corresponding to an increase in water content from 0 to 37 percent, this distance practically doubles. At higher water concentrations it is possible that some of these groups of planes become quite free from their neighbors and float off through the suspension.

Before leaving Fig. 1, attention should be called to the probable location of metallic cations and hydrogen in bentonite. It can be seen that if a water molecule should react with an oxygen atom bound to two silicon atoms in the surface plane of a crystallite, two hydroxyl groups would result. The hydrogen of these hydroxyls can ionize and be replaced by metals, and in strongly acid solutions the

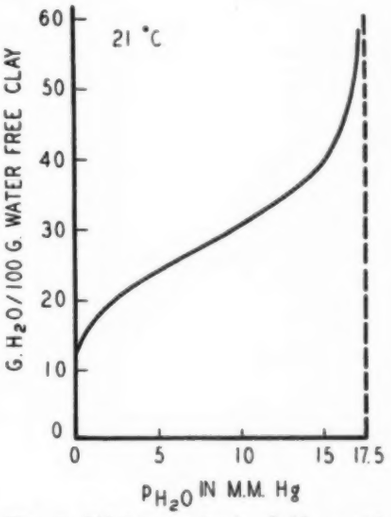


Fig. 3. Water content of Na montmorillonite

*The references indicated by numbers are listed at the end of the article.

hydroxyl group as a whole can react as a base giving clay its amphoteric properties. In addition, it is possible that there is enough room in the crystal lattice for the dissociable hydrogen ions to migrate out from the interior hydroxyl groups into solution. The dissociation of cations in the form of hydrogen or metals from the clay particle leaves it with its characteristic negative charge, and indeed it is possible to think of clay as a polyvalent electrolyte with a large colloidal anion. The dissociable ions have a definite, average, standoff distance from the surface of the particle, this distance being determined by an equilibrium between the forces of kinetic activity tending to move them out into solution and the forces of electrostatic attraction tending to restrain them within the vicinity of the surface. Since the attraction between two electric charges of opposite sign is proportional to the product of the charges and inversely proportional to the distance between them, the average standoff distance of divalent and polyvalent cations from the surface of a crystallite is less than that of univalent cations.

Hydrogen bentonite prepared either by acid washing or dialysis may be titrated to an end point with base and its equivalent weight determined as around 1000.[5, 18] The fact that the equivalent weight of a bentonite of a given origin is a constant independent of the size of the individual particles[5] is additional evidence for the open, porous structure of the clay particle as presented in Fig. 1, indicating that ions can migrate into the cracks between crystallites. Fig. 1 indicates, however, that if the lattice were to be broken up a change in equivalent weight of the clay could occur in some cases, depending on the state of aggregation of the plates. This result has been reported for some clays.[20]

It is the unusual swelling ability of bentonite that makes it so valuable as a suspending and geling agent. Kaolin, while having a layer lattice similar in some respects to bentonite, does not exhibit the variable *c* distance between its groups of planes and, as is well known, kaolin swells in water to an order of magnitude less than that of bentonite. Many muds with intermediate swelling properties may consist of mixtures of minerals of the kaolinite and montmorillonite type and the blending of such types suggests a possible method of control over the mechanical properties of the resulting suspensions and gels.

Most of the particles of kaolins are large enough to be seen under the ordinary microscope and their tendency to assume the platelike habit is unmistakable. On the other hand, the majority of the particles in bentonite are too small to be resolved under the ordinary microscope but when viewed in the ultramicroscope they can be seen indirectly as innumerable twinkles and flashes of light resulting from the changing intensity of light reflected from the faces of tiny plates twisting and turning in ceaseless Brownian motion.

Editor's Note: This article will be continued next month.

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Use of the Shroud to Prevent Valve Sticking

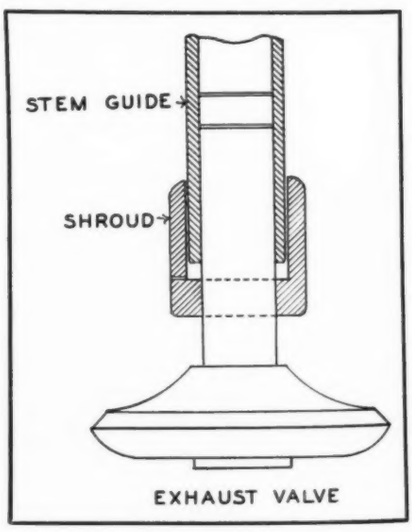
By J. L. INGRAM

EXHAUST valves that stick are always a source of trouble to the operating man. Relief is not obtained by changing the brand of lubricating oil or by replacing with a new valve. The tendency to stick may be reduced if the valve is lubricated occasionally with kerosene. Sticking of exhaust valves may be attributed to one of several causes. When a fuel containing an appreciable amount of sulphur is used sticking may be expected. The exhaust will contain sulphurous acid gas and when the engine is stopped the gas remains in the cylinder and condenses to form sulphurous acid as the engine cools. This acid is highly corrosive and pits the valve face and seats.

When the engine is running, the exhaust valve stem is partially exposed to the flow of hot gases escaping from the cylinder each exhaust stroke. Fuel and lubricating oil usually are present in the exhaust gas and eventually will cause the stem to gum up and stick.

Relief from this trouble may be obtained by fitting a shroud around the valve stem as shown in the accompanying drawing. When the shroud is used the stem is scarcely exposed and the opening is directed away from the escaping gases instead of against them.

It is a simple matter to make the shroud, but it is advisable to remove the valve and turn the lower end of the guide true to insure a snug fit. The shroud should be welded to the stem to keep it from working loose.



Panoramic view of Nitchey lease of Sunray Oil Company in Allen Pool, Oklahoma

Efficiency Increased by Modernization of Surface Pumping Equipment

Safety and appearance of property also improved by removal of obsolete structures

By J. C. ALBRIGHT

WELLS drilled in the Allen pool, Seminole County, Oklahoma, were equipped with wooden rig fronts for individual gas-engine pumping almost immediately upon being completed as producers. Many wells in this field were drilled in the channel of the South Canadian River, and because of the rough terrain along the breaks and banks of this stream, it was thought that pumping units would be the most satisfactory equipment for producing the oil. The Sunray Oil Company's property includes two 50-acre leases, and one 30-acre lease. There are 21 wells on these leases; three are gas wells and the rest are oil wells. They were drilled in 1927-28, during the early days of the field, and produce mainly from the Cromwell sand at depths of 2600 to 2650 feet.

After pumping the wells for years with the type of equipment mentioned, the individual gas engines being used for cleaning out, pulling tubing and rods, etc., the surface machinery became obsolete and was expensive to operate and maintain. The margin of profit became so small that in the spring of 1937 it was decided that new equipment was essential if operation of the wells were to be continued.

Three plans for modernizing were considered, including a central band-wheel power for all the wells, a central electrical-generating station and individual motors on each well, and gas-engine-driven pumping units having back-crank equipment. On the leases in and near the river, the ground was rough and this, together with difficulties caused by the shifting river bed, precluded the use of a central power, and the fact that the average field man's training was lacking in electrical experience did not favor the electrical-generating unit.

Sub-surface equipment on these leases had been maintained in good condition, so the properties required nothing other than the modernizing of surface equipment. The wooden derrick floors, sills, band-wheels, and houses, together with circulating tanks, all of which were of standard wood construction, presented a considerable fire hazard, which also was a factor in the decision to modernize.

At the time the program was first considered, the leases were surveyed and basic plans made, such as the determination of the size engines and other machinery required. The property lines of the Cully "A" and Cully "B" leases were disregarded, pumping

This gear box pumps the four wells on the Nitchey lease by means of pumping pendulums

A 40-hp. prime mover pulls Cully "B" 2, shown here, Cully "B" 5, and Cully "A" 6, the last being operated by means of a swing in the rod line

units and rod lines being placed as though the two tracts were a single lease. The third tract, the Nitchey lease, was surveyed separately, as it contained only four wells, every one of which could be operated from one pumping unit.

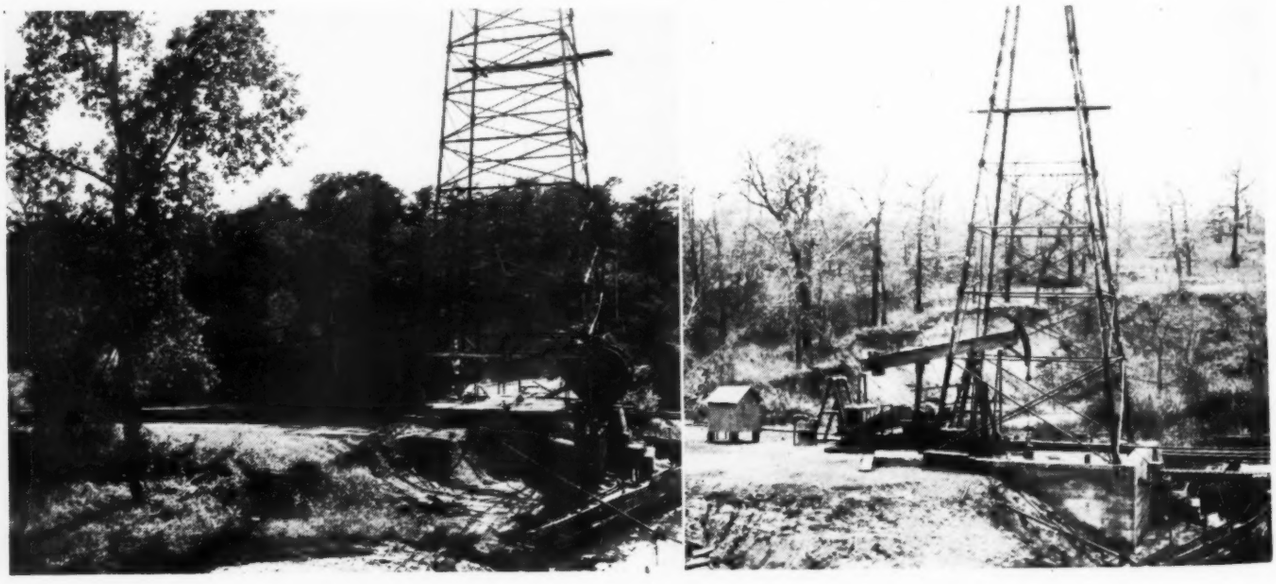
When the contract to install new machinery was made, it was thought feasible to pump river-bed wells with individual units installed on the reconditioned floors of the derricks, but a few days after the first unit was placed in operation the South Canadian River came up in one of its "wall-of-water" rises that undermined the legs of the derrick on Cully "B" 8, with the result that all the equipment was washed into the quicksand and never recovered. This changed the picture entirely insofar as the river-bed wells were concerned, and plans were made to pump remaining producers with shackle rods

Cully "B" 1, one of the wells situated under the second bank of the South Canadian River. The new pumping equipment has been installed, but the old has not yet been removed

pulled by pumping units situated above the high-water mark.

As eventually installed, there are in operation six individual units on the three leases, pumping one to four wells each. A gear box powered with a 60-hp. gas engine was installed near the center of the Nitchey lease directly be-

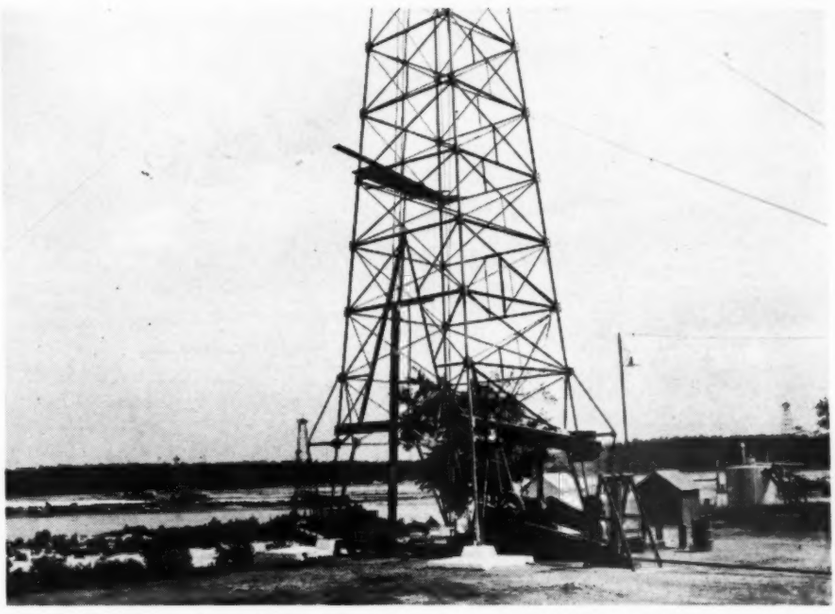
Well No. 5 on Cully "A" lease; before being modernized (left) and after (right)



Cully "B" 7, shown here prior to the installation of new surface pumping equipment, is a river-bed well having rod lines carried to it on an elevated walkway

tween wells Nos. 1 and 3. It is equipped with plain and counterbalanced cranks with pitmans connected to pendulums that operate the shackle-rod lines leading to the wells.

Cully "A" 1 is equipped with a pumping unit that pulls wells Nos. 1, 2, and 3. Cully "A" 5 is equipped with a unit that has a 40-hp. prime mover and pulls three wells. Cully "B" 2 is equipped with a similar unit that pulls Cully "B" 2 and 5; also Cully "A" 6 is operated by means of a swing in the rod line. Two units are operating under the second bank of the river, above flood level. Cully "B" 1 is equipped with one of the larger units, which pumps this well with a beam and pulls Cully "A" 8 and Cully "B"



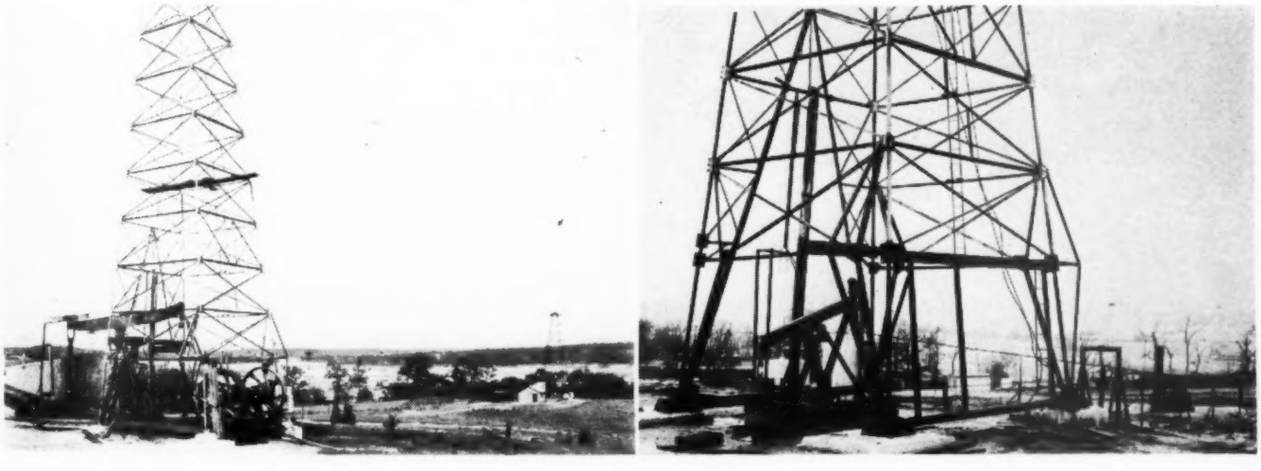
Cully "A" 1 is pumped by a back-crank equipped unit that also pulls wells Nos. 2 and 3 on the lease

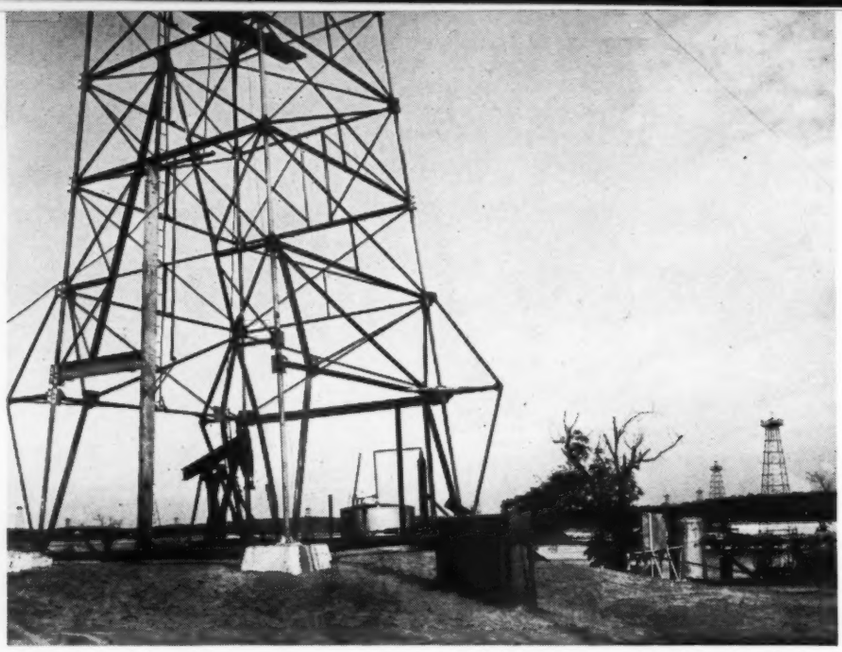
7, both of which are river-bed wells having rod lines carried to them on elevated walkways. The other unit, which was installed instead of the two individual units included in the original plan, has a counterbalanced back crank that pulls Cully "B" 6, and also will pull Cully "B" 8 as soon as the latter can be reconditioned following the disastrous flood.

Cully "A" 5 was the most difficult well to recondition. It is one of the wells most distant from the river bed and was drilled in the bank of a small creek that flows through the property. The banks are soft clay and sand that wash easily. It had been protected from high water with fender walls of planking that disappeared during some spring freshets. The well was also equipped with a drilling derrick of standard height, which was replaced with a short pumping derrick. Forms were built on three sides of the well to include the foundation piers and a solid poured-concrete wall, which prevents soil erosion around the casing.

As soon as possible after the new

No. 4 Nitchey, before and after being modernized



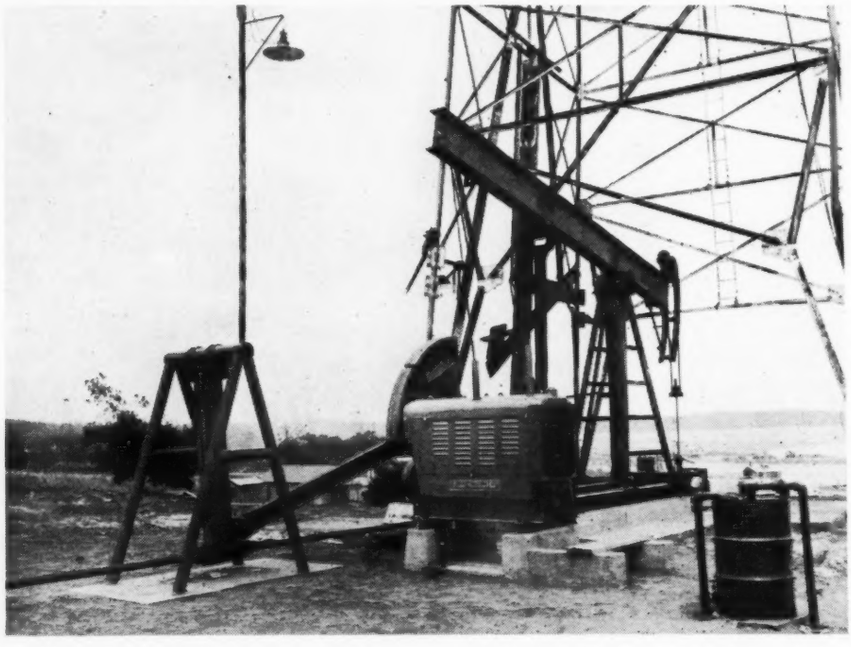


No. 2 Nitchey. A gear box powered by a 60-hp. gas engine was installed near the center of the Nitchey lease. Several wells are pumped with this equipment

equipment was installed, all wooden floors were replaced with concrete slabs to support the pumping units or jacks. All engine and belt houses were razed and all circulating tanks were dismantled and stacked for future use elsewhere. Not only has the property been improved greatly in appearance, but has been made safer. Maintenance cost has been reduced, largely through the saving in lubricating oil and belt replacement cost.

A truck equipped with a gasoline engine that drives a pulling unit is now used to facilitate repair work at the wells, as well as at others across the river. Rod hangers are a part of the equipment carried on the truck. They are placed in the derrick over the well that is being pulled, making it unnecessary to lay the rods on the ground.

Because each engine is protected by a steel hood, no housing is required. This allows plenty of "elbow room"



Cully "A" 3, equipped with a modern pumping unit

when making adjustments and thus facilitates maintenance. Guard rails made of pipe surround each part of the unit in need of protective devices, not only to prevent employees from being injured, but to prevent school children and others from being struck by counterbalances and cranks.

Cully "A" 1 before (left) and after (right) modern surface pumping equipment was installed

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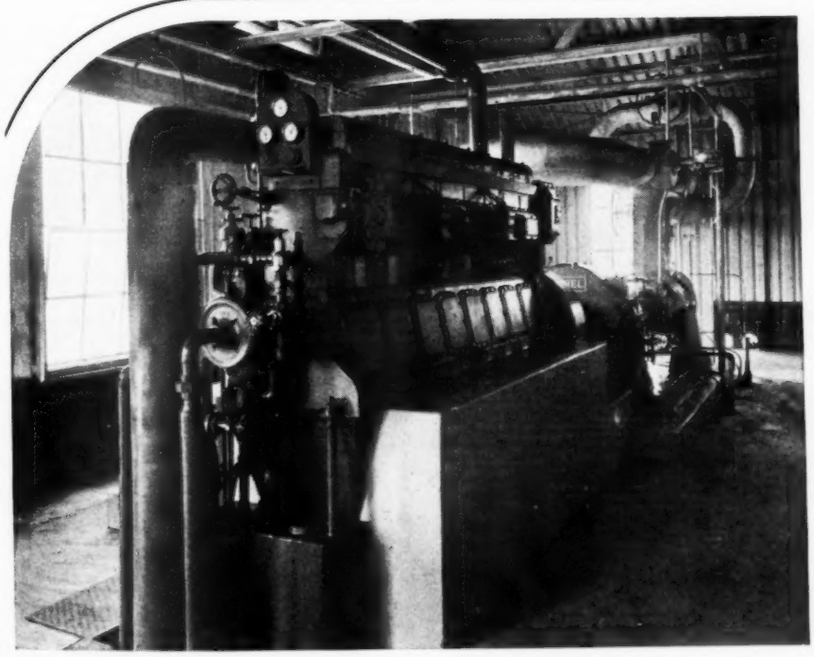

BIG SPRING, TEXAS—In this plant of Cosden Petroleum Corporation, a Cooper-Bessemer Type EN-8 vertical gas engine, rated 200—250 H. P. at 425—510 r. p. m., drives a centrifugal hot-oil pump through a speed increaser. This installation replaces steam.

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Boiler Blowdown Design

By S. C. SMITH*

A BOILER blowdown arrangement of original design has been in use for six months at the plant of the Paluxy Asphalt Company. This design, in the opinion of the writer, has many advantages.

A 2-in. blowdown line from the boiler enters a 4-in. by 2-ft. header from which extend two 2-in. lines that enter 8-in. pipes open at both ends. The 8-in. pipes are approximately one ft. from the 4-in. header and perpendicular to it. The 2-in. pipes extend approximately one ft. into the 8-in. pipes. When the boiler is blown down the steam leaving the 2-in. lines pulls air into the 8-in. pipes and most of the steam is condensed. The air, steam, and condensate travel to the opposite end of the 8-in. pipe propelled by the exhausting steam; however, the 8-in. pipes are given a slight pitch for complete drainage after the blowing down has ceased. At the drainage end of the equipment the 8-in. pipes extend two in. into a rectangular box, which is open at top and bottom and equipped with four baffles, as shown in the accompanying sketch. The purposes of the baffles are to prevent spray from escaping and to act as a muffler. The box is two ft. wide, five ft. deep, and seven ft. long.

The advantageous features of this boiler blowdown design are:

1. *Safety.* Each boiler is blown down into two 8-in. pipes, thereby eliminating the possibility of burning a workman who might be working in a boiler that was off the line. This sometimes happens when two or more boilers are blown down into a common header. On the exhausting end of this arrangement there is a very little spraying of steam and condensate.

2. *Effectiveness.* By using 100-ft. lengths of pipe practically all steam is condensed before reaching the outlet. Because of this and the muffling effect of the baffles there is very little unnecessary noise.

3. *Economy.* The entire arrangement may be made from second-hand pipe and old boiler plate, except, of course, the actual blowdown lines. The supports, not shown in the sketch, are made from discarded still tubes.

4. *Adaptability.* This arrangement is suitable for either continuous or intermittent blowing-down.

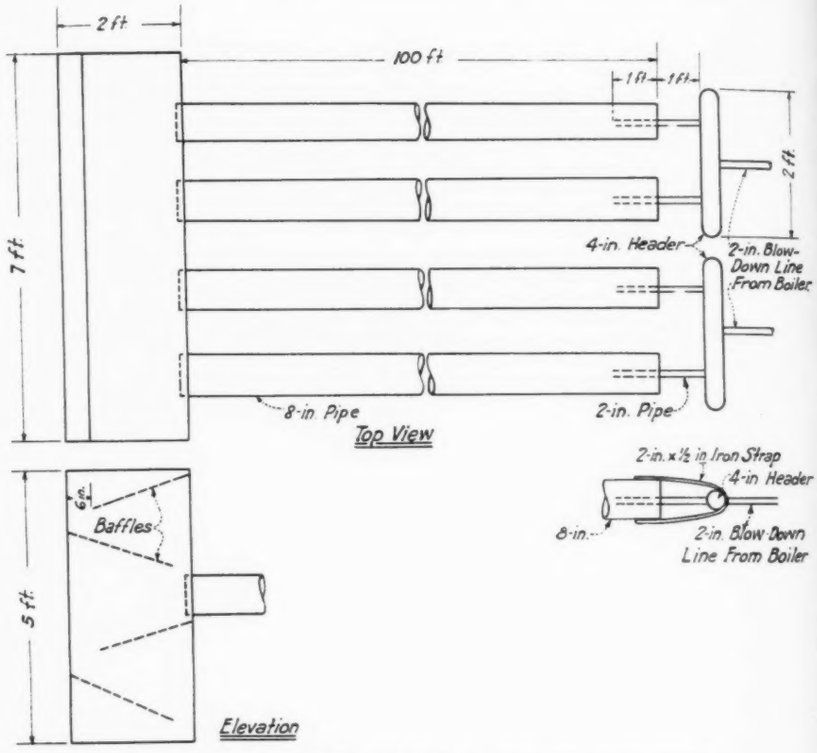

Diagram showing details of boiler blowdown arrangement

*Chemical engineer, Paluxy Asphalt Company, Talco, Texas.

Demonstration Motor Shows Automotive Progress

A demonstration motor that illustrates the romantic advance in automotive power and performance has been developed by engineers of the Ethyl Gasoline Corporation. The mechanism is described as "the only instrument yet designed that shows actually how various gasolines react in a motor."

Revealing the behavior of fuels, it pictures the striking progress that has been made in this field since Thomas Midgley, chairman of the board of directors of the American Chemical Society and winner of the Nichols and Perkin medals in chemistry, discovered, after testing thousands of compounds, that tetraethyl lead was the chemical agent that could rid engines of knock.

The motor pictures scientifically the difference in gasolines. It discloses gasoline of low anti-knock value as the source of poor performance, waste of gasoline and oil, and overheating—evils of a knocking engine, diminished power, and rising engine temperatures. Likewise, it demonstrates how knock can be made to disappear, and how greater power can be summoned.

Representing the results of a long period of improvement in devices of this kind, the motor consists of a single-cylinder 4-cycle engine originally manufactured as a farm light unit. The compression ratio, however, has been raised to approximate the ratios found in the modern motor cars, and because of this ordinary gasoline will detonate or knock whereas Ethyl gasoline will not.

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The Hughes Core Bit has proven outstanding in delivering to the derrick floor large, uncontaminated cores.

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Following are some of the major features of the Hughes Core Bit:

1. Large diameter core recovered.
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3. Double Core Catcher. Same assembly is used for both hard and soft formation coring.
4. Hard and Soft Formation Cutter Heads fit the same box connection in lower end of Working Barrel, and are easily interchanged for varying formations.
5. Vent for relieving pressure above core when entering Core Barrel.
6. Plug for keeping Core Barrel clean when running in hole.
7. Ease of dressing and handling.
8. Simplicity and long life of parts.
9. Rugged strength of all parts for safety.

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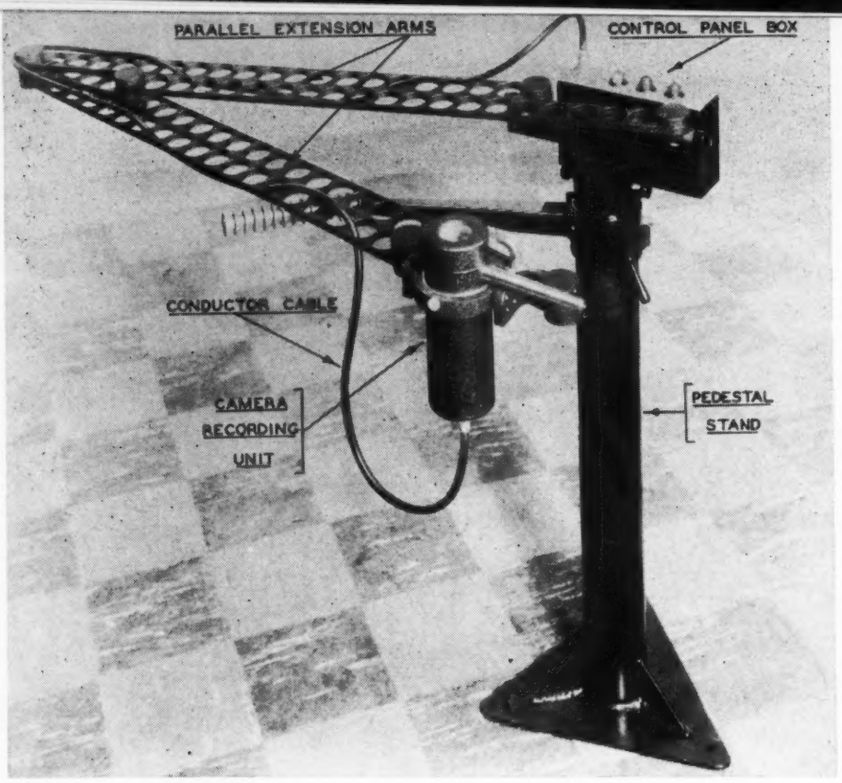


Fig. 1. Auto Photo Orienter

Apparatus promises to eliminate chance for human errors in running an oriented survey

Improved Device for Orienting Drill Pipe

By J. BENTON MURDOCH, Jr.*

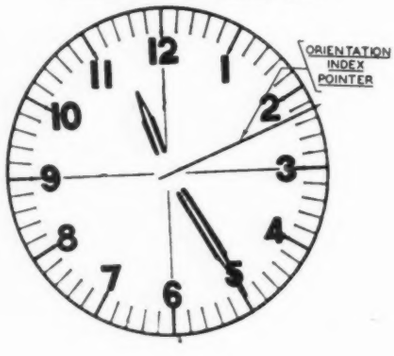
SOME 13 years ago the oil industry first accepted the accuracy of subsurface surveys of oil-well boreholes made by measuring the rotation or "orienting" the drill pipe on which a survey machine was run into the hole. From that time to the present, two basic types of apparatus have been in general use for accomplishing this rotational measurement or "orientation." The old method, although employing relatively simple apparatus, necessitated a considerable amount of computation after the field survey was run in order to obtain a true representation of the course of the hole. Drill pipe clamps and attachable sighting tubes were employed; one clamp was affixed to the top of a stand in the derrick and the sighting tube aligned upon a distant object the azimuth of which was known. The stand was then lowered to the floor and another stand made up on the string. By sighting through the tube, a reference point was marked on a lath affixed to the derrick floor at a known distance from the drill pipe. Meantime another clamp was attached and the sighting tube was aligned upon the distant object from the derrick as before. It readily can be seen that by repeating this procedure a number of reference points were obtained on the lath, which represented the tangent of the angle of rotation of each stand of pipe. These reference points were measured from a base line and the rotation angles computed trigonometrically. Corrections were made to each of these angles for the eccentric motion of the sighting bar, (in relation to the lath), as it rotated with the drill pipe. By mathematically combining these rotation angles with the readings made by the survey machine run into the hole on the oriented drill pipe the directions of inclination of the well were obtained.

The more modern application, which has been used for the last six years, somewhat simplified both the field and office work. Drill pipe clamps carrying adjustably rotative tapered chucks were employed in a similar manner but instead of sighting tubes, a telescope was used in the derrick and an ordinary engineer's transit at the floor. Both of these instruments were mounted on tapered pins that fit the chucks on the clamps. Direct measurement of the angle of rotation by use of the transit eliminated the necessity for marking

(*Continued on Page 63*)

*Chief Engineer, Eastman Oil Well Survey Corporation of California.

Auto Photo Orienter film



Survey machine film

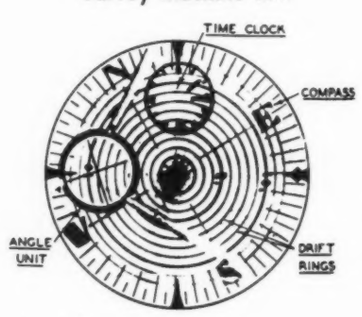


Fig. 2. Reproductions of survey and Orienter films. These photos, taken on 16-mm. film, are projected to 12-in. diameter for reading

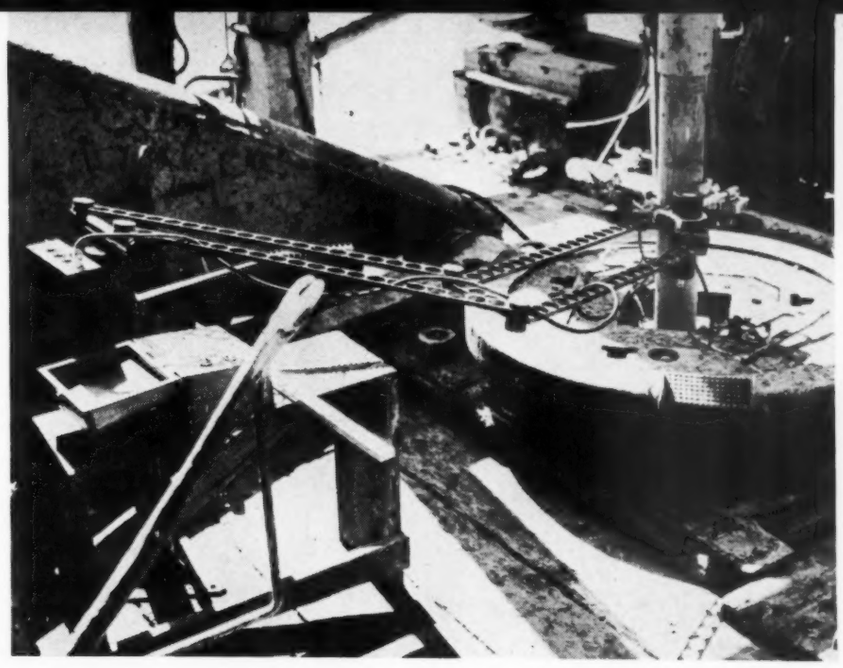


Fig. 3. Taking an Orienter record. The tapered pin of the camera-recording unit is fitted into the tapered chuck of the clamp and the manual control operated to make the photographic record

(*Continued from Page 60*)

reference points on lath and computing the angles. A clamp was placed on a pipe in the derrick, the telescope affixed in the chuck of the clamp and sighted upon a distant object the azimuth of which was known. The telescope was removed, the pipe lowered to the floor and another stand made up on the string. The transit was placed on the clamp by use of the tapered pin and the horizontal angle between the clamp chuck and the distant object was measured with the transit. This clock-wise or counter-clock-wise angle was the angle of rotation of the drill pipe. No eccentricity correction was necessary as the objects sighted were generally more than a mile distant. This method, it readily can be seen, eliminated needless computations in determining the rotation angles. These angles were converted into azimuths from the reference bearing by regarding right turns as positive and left turns negative. The survey film was projected upon a rotative compass card that was turned to the corresponding azimuth for each reading on the survey. Thus the direction readings of the survey film were graphically compensated for rotation of the drill pipe.

It was evident, however, that the ultimate in simplicity and accuracy had not been attained. There still remained a multiplicity of operations to be made in the field and office that could be eliminated, thereby decreasing the chance of human error. The less work it was necessary to perform, the less the chance for error. If the necessity for reading the transit could be eliminated, possible errors in those readings could be obviated. Simplifications of the process also would reduce the time required for obtaining the results of the survey and would reduce time lost to the well operator. The ted in the stand and they carry the problem was submitted to the Eastman development engineers. After considerable study and experimentation a new apparatus called the Eastman Auto Photo Orienter was evolved. This apparatus promises practically to eliminate the chance for human errors in the running of an oriented survey. It is, without doubt, the first major development in the method of surveying on oriented drill pipe since the adoption of the transit method six years ago.

The Orienter, Fig. 1, consists of four basic parts, the pedestal stand, parallel extension arms, camera recording unit, and control panel box.

The pedestal stand is a short steel tube, to the bottom of which is welded a triangular base plate provided with holes in order that the stand may be secured to the derrick floor. The upper end is a bearing into which is fitted the base supporting the inner end of the parallel extension arms. Clamping bolts are provided for securing the extension arm base to the pedestal.

The parallel extension arms are mounted at one end upon the base fit- camera recording unit at the other. The dural arms are pivoted at the joints with ball bearings to insure freedom of movement and accuracy of alignment. When the base of the arms is clamped to the pedestal, the camera recording unit secured in the ring at the outer end of the arms is moved in a fixed plane in relation to the pedestal at all times but allows the camera unit to be moved around the drill pipe at will. The arms thus form two variable parallelograms. When the Orienter is not in use the arms are supported by a bracket mounted on the pedestal.

The camera recording unit records on motion picture film the rotational movement of each stand of the drill pipe with respect to the reference plane. The cylindrical case acts as a hollow center for a ring carrying a radially mounted tapered pin. Within the ring is an index pointer mounted in a fixed relation to the tapered pin. Above the pointer is a special time clock. An ingenious system of clockwork gear trains operated by a manual control on the bottom of the case automatically winds the 16-mm. motion picture film and exposes the film, em-

(*Continued on Page 66*)

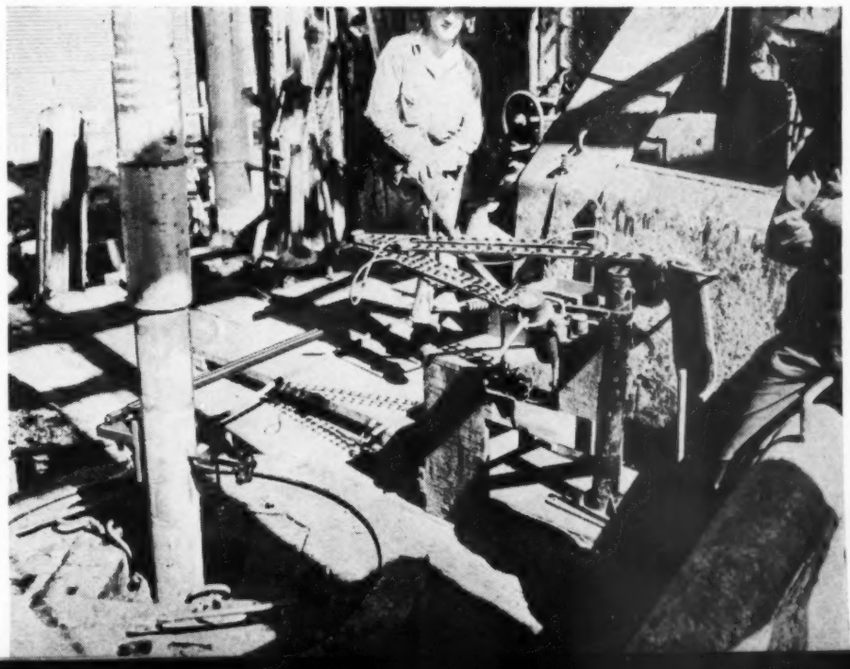


Fig. 4. Aligning bar in chuck of pipe clamp. The derrick man is sighting downward on the bar with his telescope to align the chuck of the upper clamp

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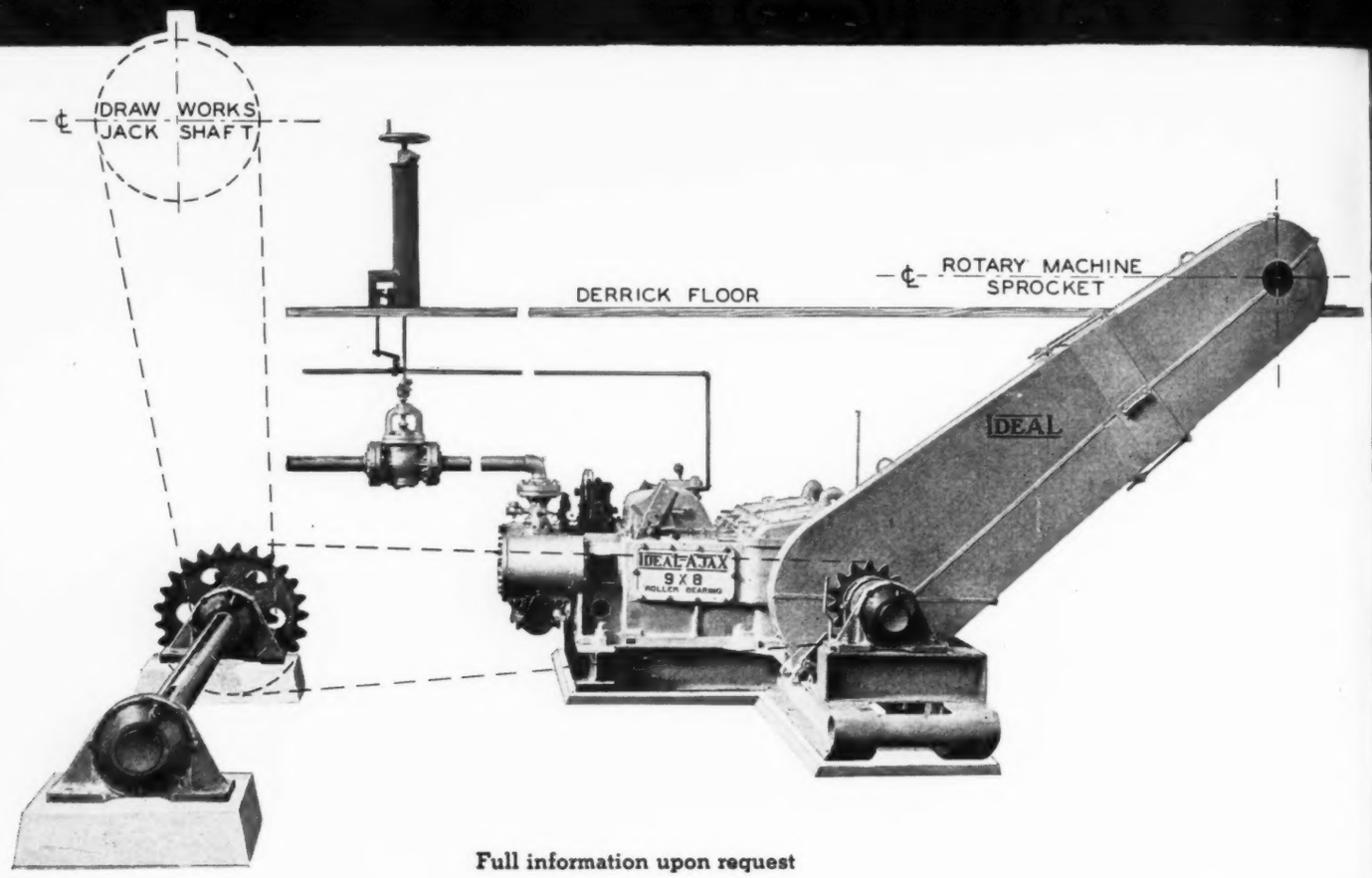

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Fig. 5. Orienter in use. Note aligning bar, which has just been removed from pipe clamp chuck. Also note that the extension arms form two parallelograms with one common side

(Continued from Page 63)

ploying a camera lens and battery-operated lights. The film thus simultaneously records the position of the index pointer and the time at which the record was made (Fig 2).

The control panel box provides a visual check that the record is being correctly taken and it also carries the batteries for operating the lights in the camera unit. When the system is correctly connected a green pilot light burns. When the camera unit manual control is operated an amber light indicates that the film is winding and a red light burns during the time of exposure. Thus the operator is certain that the record cycle is completed correctly.

An insulated multiple conductor cable electrically connects the control panel box and the camera recording units.

The orienting of a deflecting tool and of a survey machine upon drill pipe present two related but very different problems. The object of orienting a deflecting tool is to ascertain the direction in which the tool is faced at some *one* point in the hole. Knowledge of the orientation of the tool at other points in the hole is not necessary. Because an oriented survey is made up of a number of separate courses it is absolutely necessary to know the amount and direction of rotation of the drill pipe in relation to a known reference plane at a great number of points—usually each stand. The present orientation method used by the Eastman companies, (U. S. Patent No. 2,088,539—July, 1937) is rapid and accurate insofar as the orientation of a deflecting tool is concerned. The deflecting tool is faced in the direction in which it is desired to land it on bottom, and a clamp provided with an adjustably rotative tapered chuck is clamped to the pipe above the tool. A straight aligning bar provided with a tapered pin at one end is placed in the clamp chuck. An identical clamp is affixed to the top of the pipe in the derrick. A telescope equipped with a collimating hair is placed in the chuck by use of a tapered pin mounted on its base and the chuck is so adjusted as to bring the telescope cross hair parallel with the aligning bar. The lower clamp and aligning bar are removed from the pipe and the derrick telescope from the upper clamp. The stand is run in and another stand made up, the aligning bar is again placed in the lower clamp and another clamp adjusted on the top of the stand as before. This procedure is repeated until it is desired to land the tool when the pipe is turned until the chuck on the last clamp faces in the same direction as the chuck on the first clamp placed on the pipe. This method, which actually consists of scribing a vertical line down the whole length of the string of pipe, is not affected by any lack of verticality of the pipe as two planes are accurately aligned each time.

To adapt this method to use for orienting a survey machine it is necessary only to record this rotation stand by stand with the Orienter. After the derrick clamp has been adjusted on each stand the tapered pin of the Orienter is fitted into the tapered chuck of the lower clamp and a photographic record is made of the orientation index pointer that shows the relation of the survey machine to the reference plane (Fig. 3).

Preparatory to starting an oriented survey the Orienter is set up on the derrick floor at a convenient distance from the drill pipe, where the stand is secured to the floor with lag screws. The clamping bolts holding the base of the parallel extension arms are tightened and the manual control of the camera recording unit is operated to ascertain that all equipment is in correct working order. The survey machine in its protective case is made up on the drill pipe and a special telescope is fitted into the tapered hole in the top of the case. The slips are set and the rotary table is turned until the telescope is sighted accurately upon an object the azimuth of which previously has been determined. A pipe clamp with adjustable rotative tapered chuck is mounted above the survey machine case and the tapered pin of the Orienter is fitted into the chuck. Two photo records are taken with the Orienter. These represent the starting azimuth of the machine and all the succeeding orientation shots are referred directly to them. After these photos are taken the tapered pin is removed and the aligning bar is placed in the clamp (Fig. 4). The derrick man aligns his clamp as previously described. Each time a stand is run the Orienter pin is placed in the lower clamp chuck and a photographic record is made showing the orientation of the survey machine at that point, and also the time at which the record was made (Fig. 5).

After the field work of running the survey is completed the films from the survey machine and Orienter are developed, fixed, and dried. They then are placed in a dual film projector especially perfected for this purpose. Necessary switches are provided for projecting alternatively either of the two films downward upon a rotative compass card mounted upon a movable base. The compass card base is equipped with four fixed pointers representing the orienting lugs shown on the edge of the film from the survey machine. The first survey picture taken when the machine was aligned upon the known azimuth is projected upon the compass card and the card moved until the four pointers are exactly under the orienting lugs shown in the picture. A pivoted straight edge is aligned from the center across the angle unit in the photo to the edge of the card and the card is rotated until this line falls upon the starting azimuth. The survey photo is switched off and the corresponding Orienter photo is projected upon the compass card. While the card is prevented from rotating it is centered under the Orienter photo and a reference pointer is affixed to the card exactly under the image of the orientation index pointer. The Orienter photo corresponding to the first stand depth is then projected on the card; the card is rotated until the reference pointer on the card is exactly under the image of the orientation index pointer. The corresponding photo from the survey machine is projected onto the card and by aligning a movable pointer across the image of the angle unit the correct direction of the inclination of the hole at that point may be read from the edge of the compass card. The drift or angle of inclination is obtained from the radial distance of the angle unit from the center of the picture. This procedure is repeated for each stand, the compass card reference pointer being

aligned accurately under the image of the orientation index pointer in the Orienter photo each time. The compass card having been thus adjusted to compensate for the rotation of the survey machine the direction of inclination of the hole may be read directly from the corresponding survey photo that is projected upon the card. This sequence is repeated until the drift and direction readings for each stand are obtained. Computations then are made to determine the rectangular coördinates of each point on the survey.

From this detailed description of the apparatus and its operation it can be seen that computations have been reduced to a minimum. In fact no computations were made from the time the machine was started into the well until the drift and direction for each stand were obtained. Computations were necessary only to obtain vertical depths and coördinates for each stand. Advantages of the use of the Orienter over the older systems may be listed briefly as follows:

(1) By this method field work has been reduced to the mere recording of the time at which survey machine and Orienter photos were taken and the depths of the former.

(2) No lath need be used in the rig nor need reference points be recorded or marked to be measured later.

(3) The method does not rely upon the adjustment of a transit nor the accuracy of its graduations. The accuracy of the reading of the transit limb and vernier is not involved, as no such readings are taken.

(4) Each orientation record is separate and does not rely upon the preceding nor succeeding record. When a transit was used any error in reading or recording the amount or direction of rotation of the pipe vitally affected the orientation of the succeeding stands. An error of this kind on the first stand made the whole survey erroneous. With the new method each record is independently referred to the starting plane.

(5) The drill pipe is allowed to rotate at will as it is run. With both older methods it was necessary to turn the pipe back occasionally in order that rotation readings could be made. By using a 90-deg. angle bar it is unnecessary that the pipe be turned back or prevented from rotating at will. It has often been pointed out that turning back the pipe in high-angle holes tended to give erroneous readings due to frictional torque of the drill pipe against the side of the bore hole.

(6) In the office work no eccentricity corrections need be applied to the rotation angle readings as was necessary when using the older method.

(7) With the Orienter all apparatus necessary for running the survey is confined to the rig, and inclement or foggy weather does not affect the accuracy of the results. The danger of sighting upon the wrong distant targets at night is eliminated.

(8) All office work has been made graphic. No computations of any kind are made until the drifts and directions have been obtained. Orienter film is self-reading. Right and left rotations show unmistakably as such.

(9) If desired, the survey and Orienter films may be filed where they can be checked by reprojecting the survey.

Since its construction the Orienter has been used in running some 30 surveys in California fields. Whenever possible a survey machine that would give magnetic readings in open hole was used in order to check the accuracy of the orientation. The results have been very gratifying, very accurate checks having been made between the magnetic and oriented bearings. One of the best proofs of the accuracy of the method is shown in Fig. 6, which represents a plan view of a deviated hole recently drilled on Signal Hill at Long Beach, California. This well was intentionally deviated more than 1000 ft. horizontally in drilling 3361 ft. of hole. The maximum drift angle attained was 32 deg. and more than 64 percent of the well was drilled at angles of more than 20 deg. of drift. In the course of drilling it was necessary to use a number of deflecting tools, some of which left considerable "doglegs" or abrupt angles in the hole. In fact, five of these "doglegs" ranged between 3¼ deg. and 5¾ deg., which increased the difficulty of running an accurate survey on oriented drill pipe. As the well was drilled an Eastman single shot run on the rig sandline was used for surveying the well. The light line in Fig. 6 represents this survey. It was later found desirable to run an oriented survey on 5-in. drill pipe to check the single shot readings. An Eastman multiple shot survey machine was oriented into the hole and the Orienter was used. The results of this survey are shown by the heavy line in Fig. 6. Although the difference in the position of the bottom of the well on the two surveys is approximately 40 ft., it should be noted that the difference is principally caused by the drift readings in the single-shot survey being slightly higher than those of the oriented survey. This is the case in many such comparisons as the single shot readings are usually taken at each change of drift or direction in the hole, whereas the oriented survey readings are taken at each stand regardless of the deviation of the hole.

As the Orienter is further used it may be found desirable to effect minor changes in its construction that will further simplify its use and increase its accuracy, but even in its present stage of development it unmistakably represents a step forward in the science of oil-well surveying.

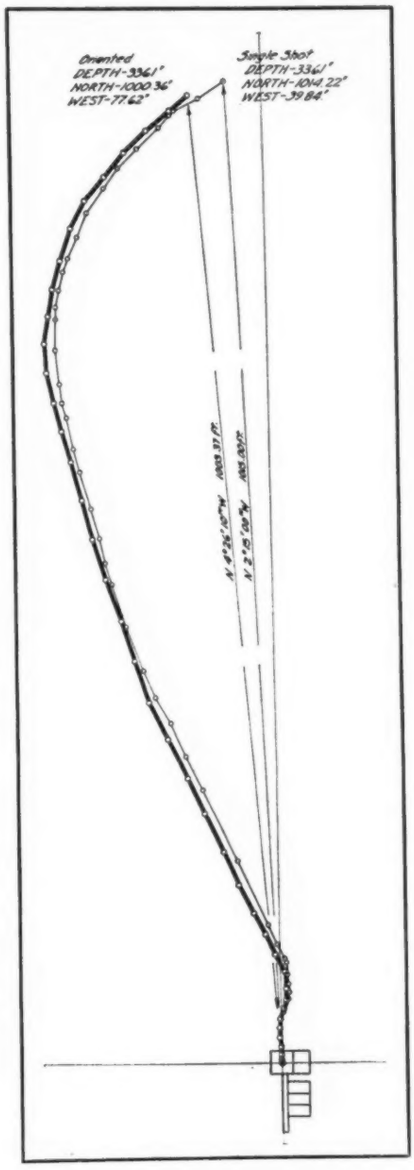
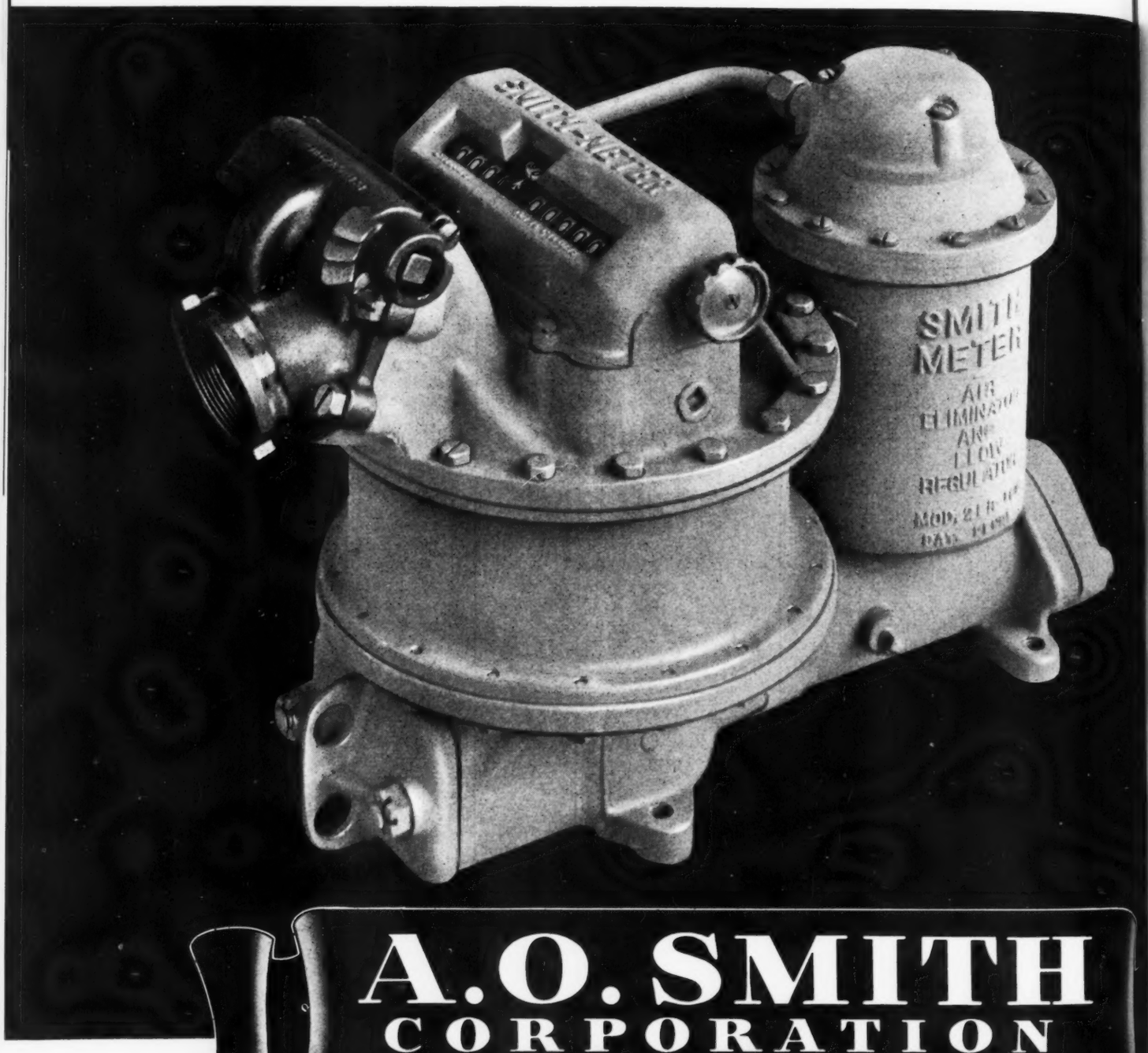


Fig. 6. Comparison of single-shot survey and oriented survey of deviated well. Plan view. Heavy line—drill pipe survey using Orienter. Light line—single-shot survey taken as well was drilled

ANNOUNCIN



A.O. SMITH
CORPORATION

Coating and wrapping machines

Preparation of pipe, application of coating, and proper handling of pipe after it is coated are factors requisite to obtaining adequate protection

By J. CAMPBELL STIRLING
Stanolind Pipe Line Company

Field Application of Pipe Line Coatings*

INTRODUCTION

DURING the last decade many tests have been made of various types of pipe-line coating materials and, as a result, many data have been collected and compiled on their behavior. Methods have been improved for testing the corrosiveness of soils and theories on the mitigation of corrosion have been put into practical use. All this information is of great value and provides something definite upon which to base a decision as to what coating materials are best suited for certain conditions; but at times too little attention has been given to the preparation of pipe, to the method of applying coatings, and to the handling of the pipe after it has been coated.

Holidays and pin-holes that occurred during the application of coatings often were not repaired. On some occasions the pipe was coated on skids over the ditch without any effort being made to coat that part of the pipe which lay on the skids. Sometimes the pipe was neither cleaned nor primed and the hot bitumen often was applied to wet or muddy pipe. In most cases no precautionary steps were taken to protect the coating from abrasions; the coated pipe frequently was lowered into the ditch by means of chains, cables, or other abrasive appliances supported from improvised hoists. The backfilled ditch often contained clods, rocks, skids, and other debris. There are known cases in which crude attempts were made at coating pipe by pouring hot bitumen into the bottom of the ditch, then lowering the pipe onto the bitumen before it had cooled; the coating operation was then completed by pouring hot bitumen on top of the pipe. These are only a few of the coating irregularities that have been employed in the past; but experience has proved that the proper application of coatings and the careful handling of the coated pipe pays big dividends in pipe protection. Today the cleaning, the priming, the coating, and the wrapping of pipe lines are done mechanically in an efficient and economical manner.

The primary reason for applying pipe-line coatings is to prevent the pipe from coming in contact with corrosive soils or waters, as it is known that ferrous metals will corrode or tend to revert to their original state when exposed to certain electrolytes, so it is obvious that if holidays or abrasions exist in the coating, the exposed pipe will come in contact with the soil and corrode. Where small areas of pipe are exposed to soils there is likely to be a concentrated corrosion in the form of pitting, which is the worst form of corrosion experienced on pipe lines.

Following is a description of the methods of procedure adopted by my company for the field application of protective coatings to pipe lines. The various steps of coating application are described in their chronological order.

CLEANING

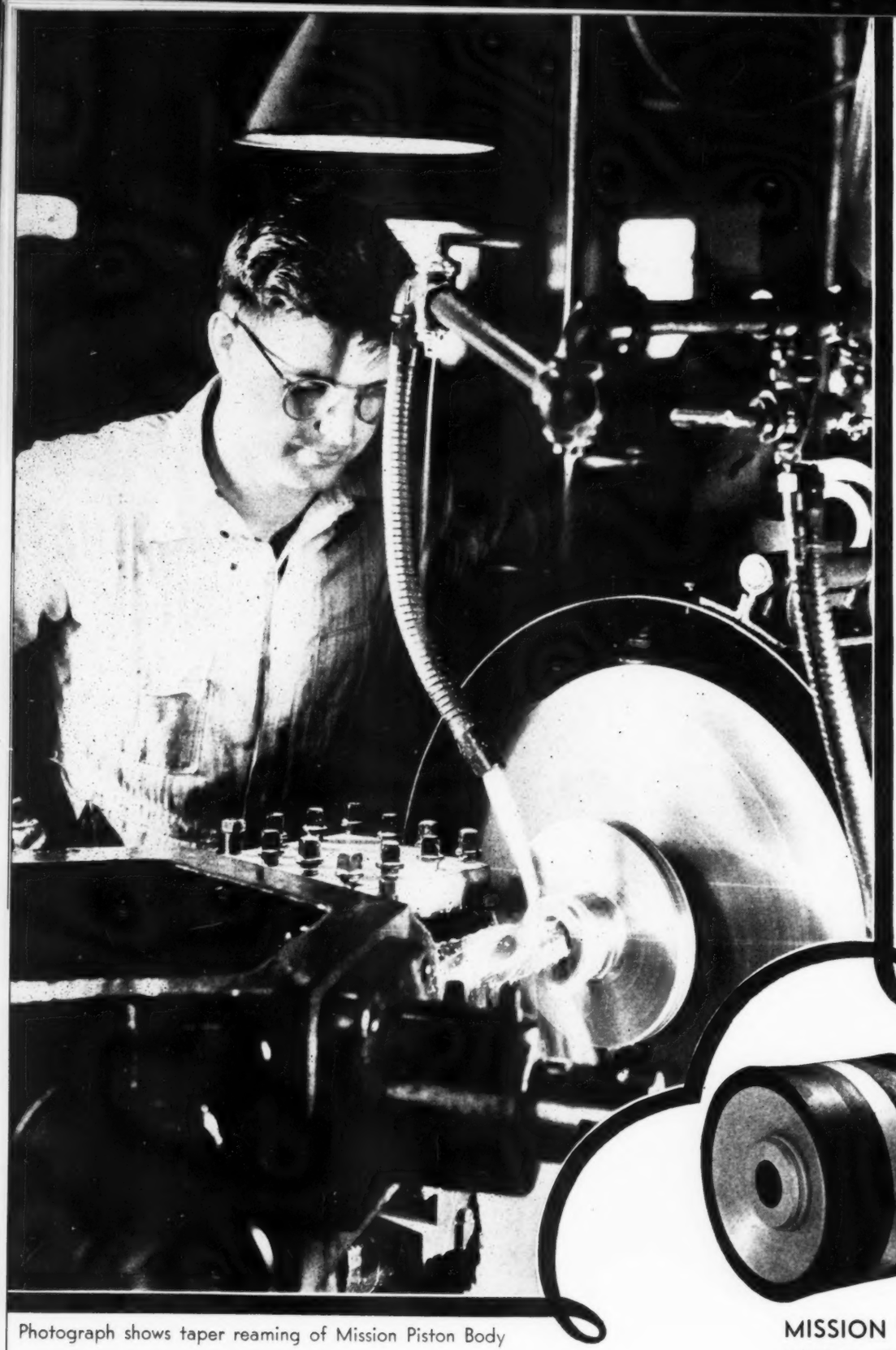
At first pipe was cleaned by hand with scrapers, wire brushes, and files. Such a procedure was very expensive and inefficient, especially so when attempting to clean pipe having a heavy coat of rust or scale. The realization that a more efficient and economical method was needed for cleaning pipe prompted the W-K-M Company, Inc., to develop a cleaning machine for this purpose. The original machine was simple in design, consisting of a single cleaning head and a Model T Ford motor mounted in tandem on a steel frame. The single head contained only a few wire brushes and cutter wheels and cleaned the pipe by revolving about it. Such a machine did not completely fill the cleaning requirements but was used by the industry until 1933, when the W-K-M Company, Inc., introduced an improved model.

This improved model is equipped with a double cleaning head which is driven by an 85-hp. motor mounted overhead. Contained in this double head are wire brushes, cutter wheels, and scraper knives that can be used in several different combinations depending on the condition of the pipe surface to be cleaned. When cleaning new pipe the best combination includes many brushes, while the removal of remnants of previous coatings is most efficiently done with a large number of scraper knives, and the cleaning of scaly pipe requires that the heads be equipped mostly of cutter wheels. Another advantage of the new machine is the different speeds, four forward and one reverse, ranging from 3½ ft. per min. to 30 ft. per minute.

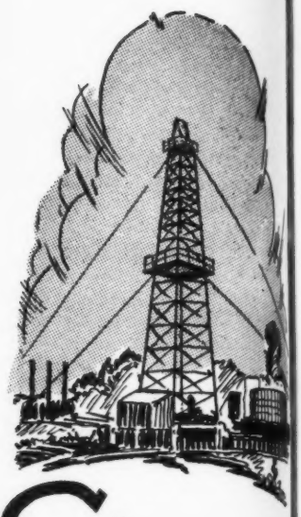
The importance of clean pipe cannot be overestimated because it is the base for the protective coating. All rust, dirt, oil, grease, mill scale, and other foreign substance should be removed. New pipe, whether primed in the mill or left bare, should be cleaned before the coating is applied; because pipe that has been primed in the mill is not usually properly cleaned and unless it is properly cleaned the mill scale in time is likely to cleave from the pipe, creating a minute air space between the pipe and the coating. Such a condition is conducive toward corrosion, especially in the presence of moisture that might have permeated the coating. In some cases the difference between the potential of mill scale and pipe is responsible for corrosion. Some pipe is pickled in the mill for removal of scale, but it rusts so severely that it is necessary to clean it mechanically before applying the coating in the field.

When using a cleaning machine on a pipe line it is highly important that a

*Paper presented at National Bureau of Standards' Fourth Underground Corrosion Conference, Washington, D. C., November, 1937.



Photograph shows taper reaming of Mission Piston Body



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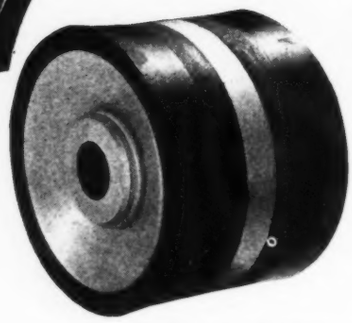

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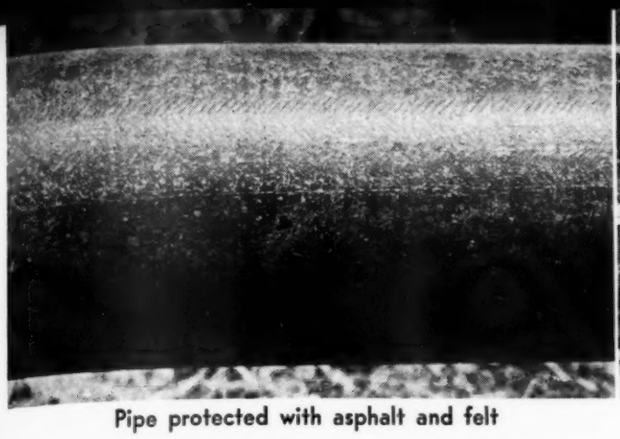
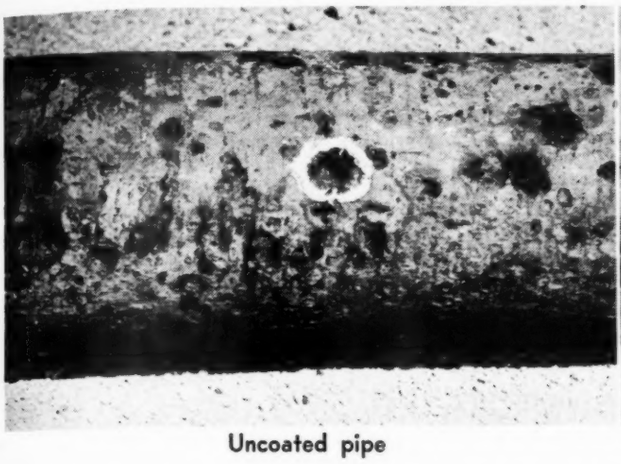


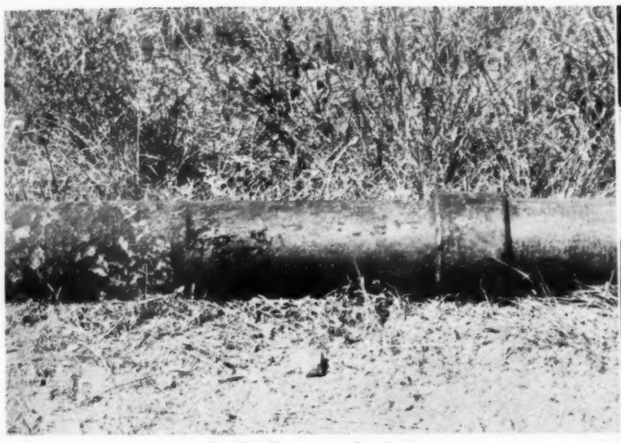
Pipe protected with asphalt and felt

Result of inadequate coating; no felt used



Uncoated pipe

Result of lowering pipe with a chain



End of coated pipe

Result of rock depressions in the coating

PIPE SPECIMENS SHOWING THE VALUE OF COATINGS AFTER TEN YEARS' SERVICE

tractor sufficient in size and equipped with a live or floating boom be used to handle the pipe from the skids over the ditch, where it was originally placed by the pipe-laying crew. The pipe line is best lifted from and returned to the skids by means of a pipe-line cradle supported from the tractor's boom.

A pipe-line cradle is made up of three V-type steel rollers connected by two jointed steel bars and is supported by two elevator hooks. When in action the rollers of the cradle move along underneath the pipe, as the tractor moves forward, automatically raising it from and returning it to the skids.

With a cleaning machine, tractor, cradle, and the necessary small tools a crew of four men can clean an average of two miles of pipe per day, at less than half the cost of hand-cleaning. In addition to the saving in labor there are three other important benefits derived from the use of this equipment: a better cleaning job, decreased liability, and more progress.

A better cleaning job is the greatest benefit derived from the use of a cleaning machine, because it is highly important that a clean pipe surface be obtained to insure a good bond with the primer. Decreased liability is the result of fewer men being used with this equipment. More cleaning progress contributes toward speeding up the whole pipe-laying program.

In conjunction with the cleaning of the pipe is the priming operation, which is actually done with the aid of the same tractor and is so closely allied to the cleaning operation that, in reality, it is a part of the cleaning operation, but in order to clarify the procedure it is described here separately.

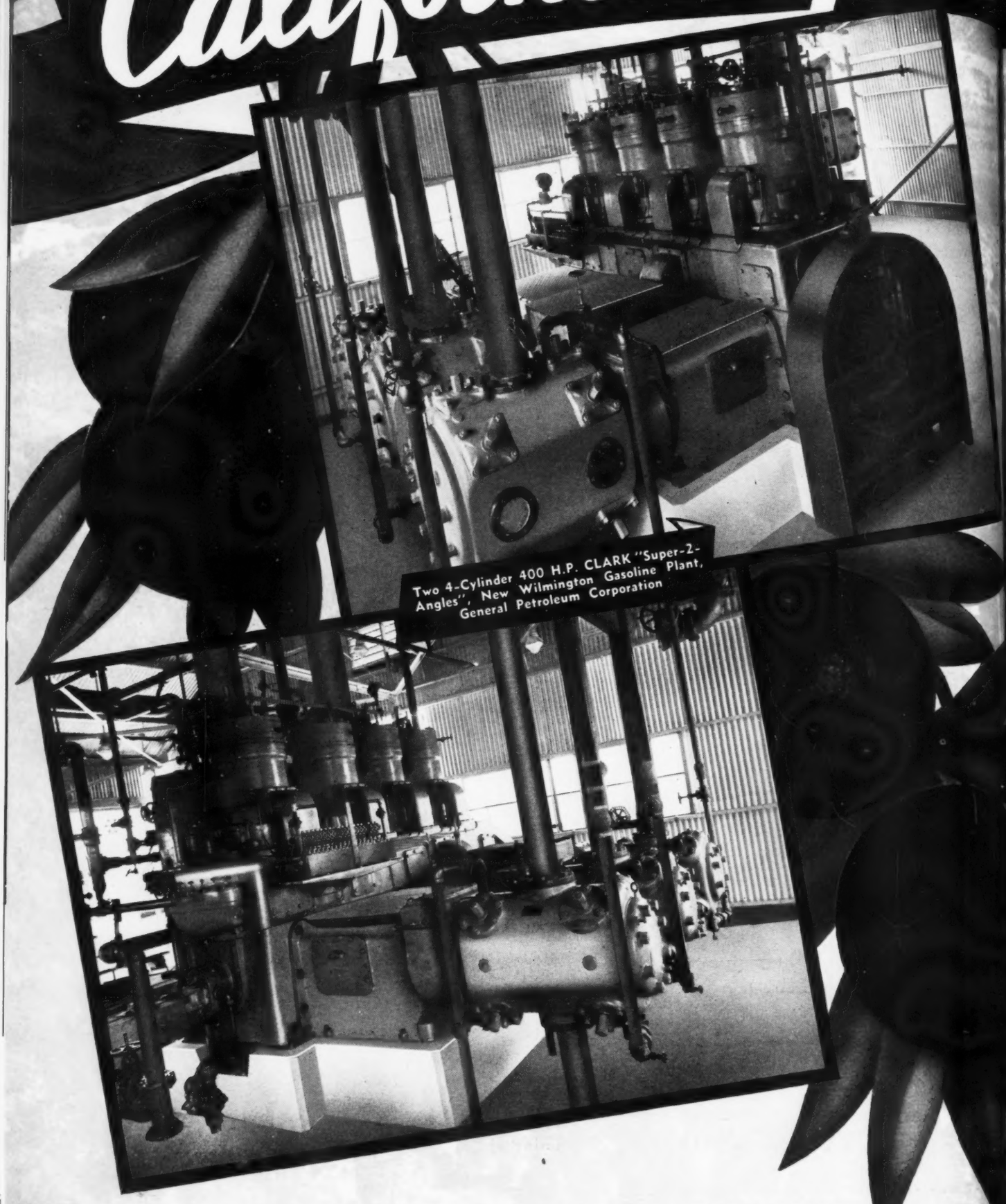
PRIMING

Some companies have a coat of primer, lacquer, or oil applied to their pipe in the mill, while others prefer to have their pipe shipped from the mill without any primer.

It is the policy of our company to decide with each job which plan to follow, depending on climatic conditions at the pipe's destination. If the pipe is to be laid soon after its arrival

(Continued on Page 76)

California Goes



Two 4-Cylinder 400 H.P. CLARK "Super-2-Angles", New Wilmington Gasoline Plant, General Petroleum Corporation

Photo Courtesy of "Sunkist"

"2-Cycle-Angle"!

General Petroleum Installs CLARKS in Latest Plant at Wilmington

GENERAL PETROLEUM originally selected the two CLARK 4-cylinder, 400 H.P. 2-cycle-angle compressors shown on the opposite page; and subsequently ordered two more of these units for the extension of their new natural gasoline plant at Wilmington.

The CLARK "Super-2-Angle" is chalking up new records for economical installation and economical operation. These units are enjoying a sensational national success because they are equal to horizontal compressors in power and efficiency, yet accomplish 5 substantial savings, viz: (1) Shipped assembled, they cut transportation and erection costs; (2) They require much smaller foundations; (3) Require less floor space, smaller buildings; (4) They save fuel, due to CLARK Super-2-Cycle Fuel Injection; (5) They save on maintenance, due to extreme mechanical simplicity.

The 4-cylinder 400 H.P. size is the most economical size that can be installed, giving lowest dollar cost per 1,000 cubic feet of gas delivered. In economy this unit is not only superior to any other size, but to any other unit on the market.

We will gladly furnish the complete engineering facts and figures on the CLARK "Super-2-Angle", furnished in 2, 3, 4 and 6-Cylinder sizes, ranging from 200 to 600 H.P.

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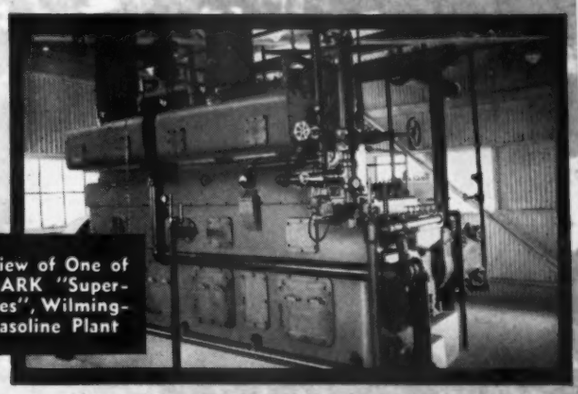
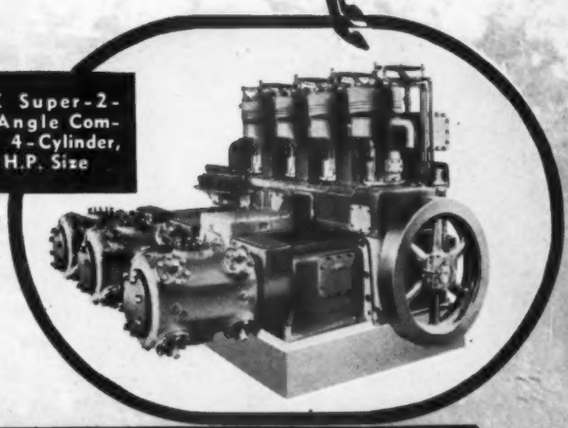


Rear View of One of the CLARK "Super-2-Angles", Wilmington Gasoline Plant



CLARK Super-2-Cycle Angle Compressor, 4-Cylinder, 400 H.P. Size

CLARK

Cleaning and priming machines

(*Continued from Page 73*)

and during dry seasons, the mill primer is usually omitted; but primer is applied at the mill when weather conditions are likely to be unfavorable for line construction or if the pipe is likely to be exposed to the elements for a long period of time. This is done to prevent a heavy coat of rust from accumulating over the entire surface of the pipe. A light coat of rust is desirable because it frees the mill scale and roughens the surface of the pipe, affording a good base for the primer paint, but a heavy coat is too difficult to clean.

If a mill primer is applied to the pipe it should be a thin, hard, and quick-drying material; as a thick, soft, or slow-drying material will gather dirt, cinders, sticks, and other foreign objects from the time the pipe leaves the mill until it is prepared for the coating. It was my experience in 1931 when cleaning 200 miles of pipe which had been primed in the mill with a heavy viscous material, that it was necessary to remove the primer with a solvent. This was an expensive operation but was essential because the debris that was embedded in the primer could not be removed with wire brushes and scrapers. Difficulty is experienced in removing sticky primer even with the efficient cleaning machine of the present day.

The field priming coat should be applied immediately after the pipe has been cleaned. Until recently our company applied the field priming coat by pouring the paint on top of the pipe and allowing it to run off onto a carpet belt which was manipulated back and forth around the pipe in a manner to spread the paint. It was difficult to regulate the flow of the paint, resulting in a thick coat in some areas and a thin coat in others. There was also a great amount of waste.

Several men with paint brushes were used to brush the priming coat and to obtain a complete coverage. Although the primer had been brushed it remained green for several hours, and under ideal weather conditions the pipe could not be coated with the hot bitumen for a period of two to eight hours.

At the time the primer was applied it was necessary to support the pipe with skids at approximately 40-ft. intervals to keep the fresh-painted pipe from touching the ground. As soon as the primer had dried sufficiently to allow handling, the pipe had to be raised and the supporting skids moved so that the areas where the primer had been damaged could be repainted. This made it necessary for the priming crew to cover the line twice, which slowed down progress and increased the operating cost. Several plans were tried with the idea of eliminating this duplication of work but none had proven satisfactory until the W-K-M priming machine was developed.

The priming machine works on the same principle as the W-K-M cleaning machine, in that the priming head revolves around the pipe. However, it has no powered traction for moving it along the line so it is usually attached, by means of a skeleton framework, to the rear of the cleaning machine. By this arrangement the priming machine is held upright and pulled along the line. The priming machine being a separate unit can, when necessary, be detached from the cleaning machine and used for re-priming the line or for priming short sections of pipe. It has a hand crank, similar to that of an automobile, which can be used to move it along the line when it is detached from the cleaning machine.

When using a priming machine it requires only two men to do the priming operation, whereas it requires six to eight men to perform the same operation manually.

This priming machine increases the daily progress and also effects a saving of 30 percent of the paint formerly used by the blanket application method. It applies a thin, uniform coating, free of drippings, that dries quickly. The time required for drying being so short it is possible to keep the hot coating within a few hundred feet of the priming operation. This increases the progress and decreases the cost of the application of pipe-line coatings as it allows all the operations to move simultaneously across roads, creeks, swamps, and other areas of caving ditch. Whenever this procedure is followed it is only necessary to raise the pipe out of hazardous places once; at which time it is cleaned, primed, coated, lowered into the ditch, and backfilled. Fewer skids are used, effecting both a saving in initial cost and in handling.

Among other benefits derived from keeping the coating and priming operations close together are:

1. The amount of dirt and mud that accumulates on the freshly cleaned and primed pipe is decreased.

2. In winter little or no frost gathers on the pipe between the two operations. Such an arrangement is especially beneficial because under the old plan it was necessary at times to spend several hours daily wiping the pipe clean. It is most important that all dirt and frost be removed before the hot coating is applied.

COATING

At first the quantity of bitumen used in the application of pipe-line coatings was insufficient to provide adequate protection. This, combined with the haphazard method of application and the careless handling of the coated pipe, caused numerous coating failures. The purpose of the coating was defeated before it had a chance to prove its worth.

Knowing that steel pipe would corrode when exposed to certain soils made it necessary to develop means to protect buried pipe or face the problem of renewing certain sections of pipe lines at regular intervals. As a result of this realization many coating materials were offered as a panacea for corrosion problems. Some companies entered into extensive and expensive reconditioning programs using untested materials. Again, the result was coating failures. Some had better results than others. The better results in most cases were due to thicker coatings or to shields and reinforcements. Few realized the reason for the better behavior of some coatings until the results of the coating tests conducted by the Corrosion Committee of the American Petroleum Institute and the American Gas Association were known.

The coating tests conducted by the American Petroleum Institute and the American Gas Association under the supervision of the National Bureau of Standards proved three things:

1. Regardless of the type of bitumen used the protective value of the coating is increased with the thickness.

2. Shields or reinforcements add materially to the effectiveness of any bitumen.

3. Asbestos felt is preferable as a shield or reinforcement.

As a result of these tests and our own experiences, we have standardized on a composite coating of asphalt and asbestos felt. Asphalt of 3/32-in. thickness is applied to the primed pipe, followed by a bonded wrapping of asbestos felt which is covered with an outer coat of asphalt of 1/16-in. thickness.

Tests have shown there is little to choose between the behavior of various types of bitumen, so we have elected

to use Parolite, a pure petroleum asphalt. The cost of Parolite being less than filled asphalts and enamels allows the application of a thicker coating of Parolite at the same cost. We have also elected to apply the coatings to the pipe in the field after it is laid and not in the mill.

Our company uses asbestos felt because there are known cases where organic materials have disappeared completely from between two coats of bitumen, leaving a void.

Although the asbestos felt is saturated with asphalt and is bonded to the under coat of bitumen, a flood coat is applied to aid in water-proofing the composite coating and to increase its thickness. However, it has not been proven that a flood coat of bitumen affords any more protection to the pipe than if the same material were added to the inside coat, so we are considering the possibility of increasing the thickness of the bitumen under the felt and eliminating the flood coat. If the flood coat is eliminated the thickness of the composite coating will remain the same. This would reduce the application cost materially, eliminate most of the waste, and decrease the action of soil stress on the composite coating, as felt is less affected than bitumen.

Without a reasonable doubt numerous coating failures have been directly attributed to ineffective application and to careless handling of the coated pipe; so this company decided that the type of material used was only partly responsible for the pipe protection received, and that the coating had to be applied to all areas of the pipe and protected when placed in the ditch. If the coating costs were to be kept within economic limits the coating had to be applied rapidly and efficiently.

To keep within the economic limits it was necessary to speed up the application procedure, which meant the replacing of hand methods with mechanical equipment. The task of revolutionizing the application of coatings was undertaken by degrees and the most inefficient phase of the procedure, the application of the felt, was tackled first. A machine for applying felt was developed by the Johns-Manville Company.

This machine is revolved about the pipe manually and its movement along the pipe is governed by the angle of its rubber rollers with the pipe. The wrapping machine has done much toward decreasing the cost and increasing the speed of the application of composite coatings. It has also effected a saving in felt.

Another machine that has aided in speeding up coating applications is the Gardiner Coating Machine. This machine is virtually a split cylinder which buckles around the pipe. To place a machine on or to remove it from the pipe requires less than a minute. The machine is divided into two compartments bolted securely together; a carriage that contains the wheel system by which it is supported and moved along the pipe, and a material compartment that holds the well of material in which a section of the pipe is submerged. The principle on which it is based combines a hot dip with a hot trowel, and the coating is ironed down to any thickness desired. Gardiner Coating Machines are simple to operate and light to handle as they weigh approximately fifteen pounds per inch of pipe diameter.

There are several distinct advantages of machine application:

1. Uniformity of coating thickness.
2. Continuity of coating with fewer voids and holidays.
3. Waste of material is reduced.
4. Speed of application is increased.
5. Workmen are protected against burns.

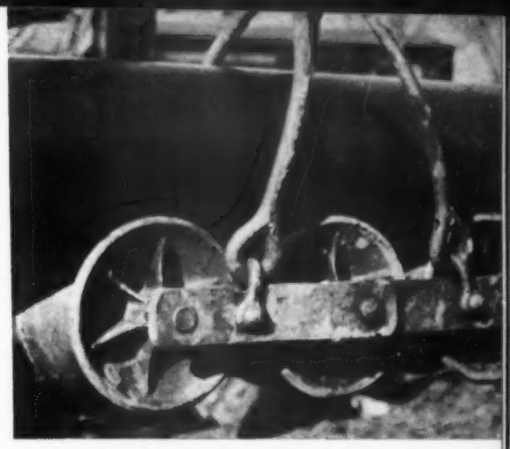
It is very important that a tractor with a floating boom, and sufficiently large, be used to lift the pipe and yet maintain a safe distance from the ditch to prevent caving. To facilitate the coating operation it is necessary to support the pipe with a cradle attached to the tractor's boom.

Another important item is the equipment for the heating of the bitumen. In order to get the full benefit of other equipment mentioned it is absolutely necessary that sufficient kettles be on hand to supply all the material that can be applied to the line. Approximately 200-gallon capacity per inch of pipe diameter is required.

As the tractor moves along the right-of-way, parallel to the line, the pipe is raised by aid of the cradle high enough above the ditch to permit the coating operations to progress systematically. Immediately in front of the cradle two men are kept busy pulling skids and wiping dust from the pipe. Following the cradle is the coating machine applying the asphalt, into which the felt is wrapped before it cools; thus insuring a bonding of the asphalt and the felt. The final application is a coat of asphalt hand applied to the outside of the felt.

LOWERING

Following the application of the flood coat of bitumen the ditch is cleaned of all rocks, skids, clods, and other foreign objects; so that the coated pipe can be lowered into the ditch as the coating crew moves forward. Only slack loops are held out of the ditch at the time the coating is applied. The slack loops are usually lowered into the ditch at the coolest time of the day, because it is then the line has contracted to its shortest length. The coating is firmer at this time and can stand handling better.



Pipe cradle

Before the coated pipe is lowered all rocky ditch is padded with four to six inches of loose soil. Nothing but non-abrasive canvas slings are used for lowering the coated pipe into the ditch.

BACKFILLING

Before the trench is backfilled in rocky areas there is a covering of six inches of loose soil placed over the pipe. All skids and other refuse are removed from the dirt spoil before it is placed in the trench. Every precaution is used to protect the coating so that the coating will protect the pipe.

CONCLUSION

This company has had many cases in which a composite coating of Parolite and asbestos felt, applied properly and handled carefully, has protected pipe in corrosive soils. It was our experience in 1936 to observe pipe that was coated with asphalt and asbestos felt to be in good condition after being buried for 13 years in the alkali flats of the Platte River in Nebraska. Adjacent to this was unwrapped pipe that was almost beyond recovery as many joints had 15 to 18 penetrations.

The evidence that composite coatings of asphalt and asbestos felt, properly applied and carefully handled, will protect pipe is so strong that this company feels safe in reducing the wall thickness of the pipe and applying coatings in lieu of thicker-wall pipe. The saving in pipe wall more than pays for the coating; but, in order to make this saving, the coating must be applied economically, which requires that the coating operations be efficiently organized and properly equipped.

In the last ten years the daily average progress of coating application has increased from 2000 feet to 7000 feet. At present there is a combination coating and wrapping machine being developed which it is hoped will increase the progress of coating applications to a daily average of 10,000 feet.

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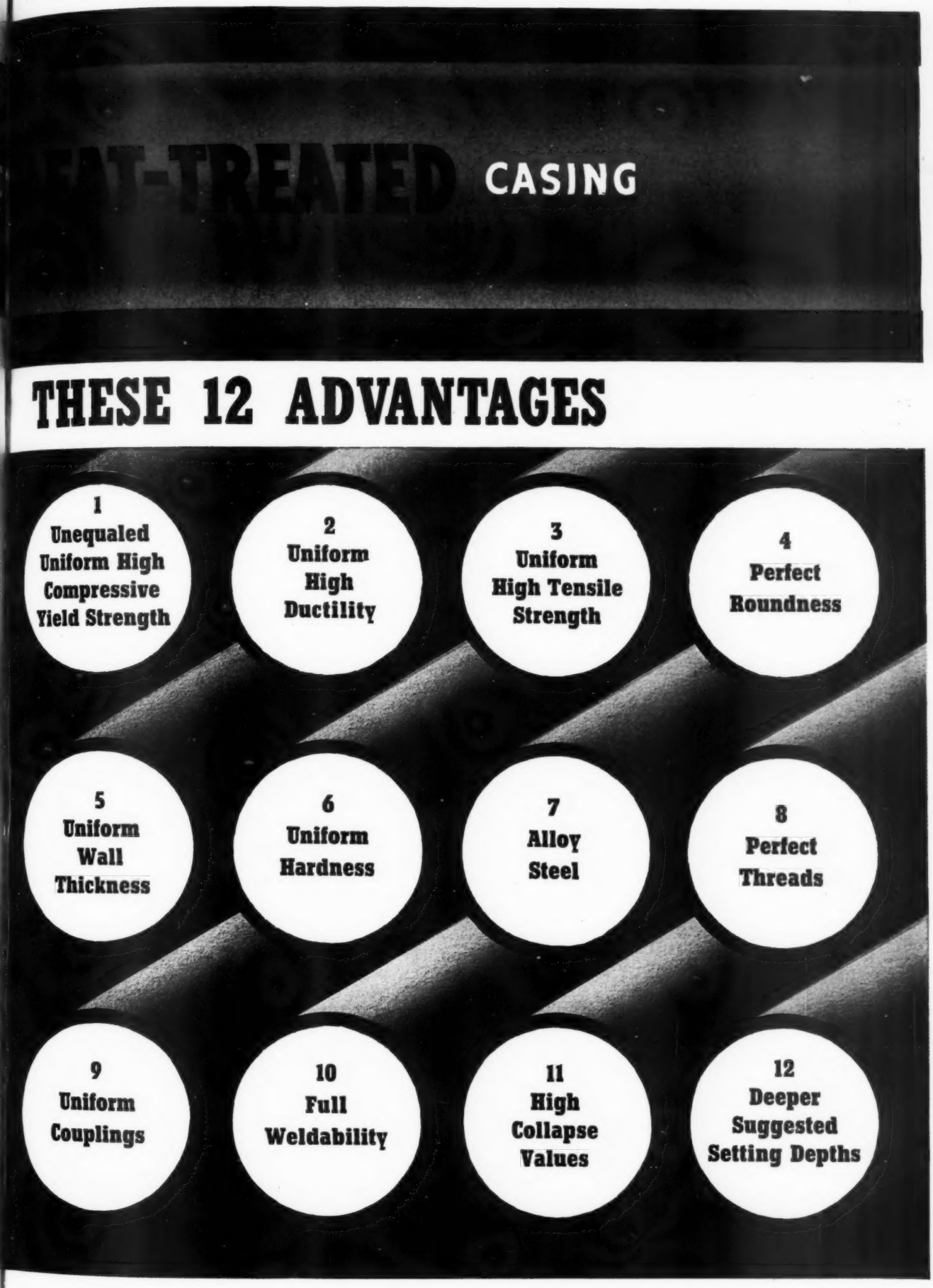
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6 Uniform Hardness
7 Alloy Steel
8 Perfect Threads
9 Uniform Couplings
10 Full Weldability
11 High Collapse Values
12 Deeper Suggested Setting Depths

Bleaching Clay

Part 6

The adsorption process in the percolation method

By
RAFAEL FUSSTEIG

THE oldest and best known method in the petroleum industry for decolorizing oils by means of bleaching clays is the percolation process. Fuller's earth and bauxite are nearly always employed as adsorbents in refining by percolation. Fuller's earth adsorbs primarily the color-forming substances; bauxite removes the sulphur compounds. Olsson[1] recommends for refining by percolation a mixture of 75 percent bauxite, 5 percent bentonite, and 20 percent starch, heated to at least 1300 deg. fahr. and then cooled.

Refining by percolation through adsorbents is usually applied to paraffin waxes and lubricating oils, sometimes to kerosenes, and very rarely to gasoline, except in combination with other treatment. For instance, Stoll[2] filters gasoline through adsorbents immediately after it is condensed. The filter is attached to the outlet pipe of the condenser. This cold filtration of the liquid is claimed to be preferable to filtration of vapors before condensation.

The adsorption process in the percolation method can be explained as follows: in the first phase the oil is sucked into the bleaching clay at the moment of contact with the adsorbent. In the second phase, the coloring matter, acids, asphalt- and resin-like compounds are quickly adsorbed to the interior of the microscopic channels of the adsorbent. Thus, pure oil remains in the upper part of the channels. Additional molecules of the adsorbable matter diffuse into the interior of the microscopic channels, slowly filling the upper part with the same impurities. The impurities diffuse continuously; the excess of pure oil leaving the channels rises to the higher layers. When all the microscopic channels are filled with adsorbable matter, the adsorbent is exhausted, and the adsorption power disappears.

The period of activity of an adsorbent depends on the one hand upon the structure and the size of grains, and on the other hand upon the characteristics of the adsorbable matter and upon the temperature. The adsorbent is more quickly saturated if it is ground fine, if the molecules of the adsorbable compounds are small, if the oil is non-viscous, or if the temperature is high.

It is particularly interesting to note that percolation not only separates the oil into fractions of different color, the first fractions treated being bleached much more than subsequently treated fractions, but also tends to separate oil into fractions of different viscosity, the first fractions treated being much less viscous than the later fractions. A curious characteristic of higher molecular hydrocarbons is responsible for this result; they are able to displace lower molecular hydrocarbons from the interior of the microscopic channels. For instance, if a bleaching clay is saturated with paraffinic hydrocarbons, and afterwards an asphaltic compound is passed through a layer of the clay, the asphaltic compounds displace the paraffinic hydrocarbons. This phenomenon can be easily observed because the first fraction is quite colorless and its constituents can be chemically identified as paraffinic hydrocarbons.

The separation of an oil into fractions of different characteristics can be explained as follows: at the beginning of the percolation process when the first fractions pass through the fresh adsorbent, the asphaltic compounds will be adsorbed in the lower zones of the adsorbent, the higher molecular lubricating oils in the intermediate zones, and finally the lower molecular hydrocarbons will be adsorbed by the top zone of the filtering material. Inasmuch as the microscopic channels of the bottom zone of the filtering material are completely filled with asphaltic compounds, subsequent fractions containing asphaltic compounds flow to the higher layers, displacing the higher molecular lubricating oils from the interior of the microscopic channels. These displaced lubricating oils flow to the highest layers, in turn displacing the lower molecular hydrocarbons. Thus, these lower molecular oils are drawn off as the first fraction.

Later fractions are enriched with higher molecular hydrocarbons, and have, therefore, greater specific gravity, viscosity, etc. The writer has passed a thinly liquid Polish crude oil from Klenczany through a percolator of Fuller's earth and received first a gasoline-like fraction. The last fraction presented a thick vaseline-like appearance.

In decolorizing lubricating oil by percolation through granular earths generally the acid is first neutralized and the earth thoroughly washed with water. A caustic wash before the acid-clay treatment has been found by V. Kalichewski[3] to be extremely helpful in producing a more stable color or a better color. The alkali treatment of lubricating oils after the acid-clay treatment[4], or between two acid treatments, of any stock[5] may improve the color, but may be difficult to perform.

The temperature during the percolation process plays a very important part, and must be determined experimentally for each oil. For cylinder stock it is usually approximately 220 deg. fahr., for other oils it is not more than 100 deg. fahr., and for paraffin waxes it is usually approximately 25 deg. fahr. above their melting points. Of course, excessive temperatures are to be avoided, because decomposition and polymerization of certain hydrocarbons occur, resulting in clogging of the microscopic channels by the higher polymerized coke substances, and in darkening of the oil. Therefore, if the oil is too hot, it should be cooled before it is filtered.

The apparatus used in the percolation process, the so-called percolators, consists of vertical cylindrical tanks provided with manholes at each end, with perforated false bottoms placed above the bottom manholes or outlets to retain the Fuller's earth yet permit the oil to pass. Percolators may be any general size, but they are usually 6 to

10 ft. in diameter, and 10 to 14 ft. high. The shape of the percolators is unimportant. The percolators are filled with the adsorbent, a free space of one to two ft. being left at the top and bottom. The charging of the adsorbent material requires special care, because the bleaching power of coarse-grained adsorbent material may only be fully utilized when the material is packed homogeneously, so that each oil particle comes in contact with the adsorbent material. The size of the bleaching clay granules plays a very great part in the bleaching results obtained by percolation. The larger the grain, the smaller is its adsorption power. The smaller the grain, the greater is the frictional resistance to be overcome, this resistance being dependent also upon the viscosity of the oil. The finer sizes are more efficient because of their greater surface area, but the degree of fineness that can be employed is limited by such mechanical difficulties as the rate of oil filtration and the losses to be encountered in regeneration of the earth. It is, therefore necessary to determine the relationship between such factors as the height of the column, the granular size of the adsorbent, the density of packing, the viscosity of the oil that is to be decolorized, and the temperature at which the percolation process takes place.

As previously mentioned, the percolating filter is the oldest method known in the oil refining industry. The first percolators were used for clarification and dehydration of refined lamp oils (Fig. 1). The adsorbent used in this percolator was a mixture of thick sawdust and table-salt arranged in several layers. The bottom and top were covered with filter cloth. The success of this type of percolator led to the development of the percolators to bleach or to desulphurize oils. Many types have been proposed for this purpose, the most important being a battery of three columns (Fig. 2). Of course, they are

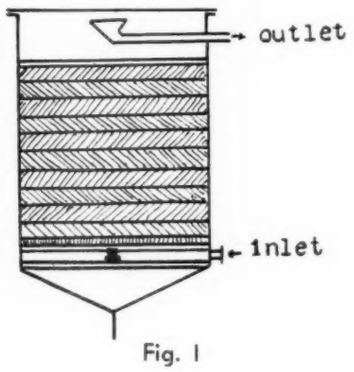

Fig. 1

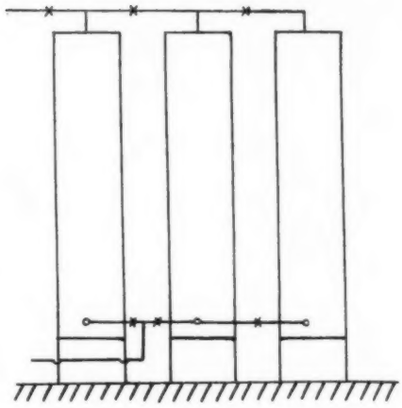
Fig. 2

placed in a warm room, and the battery of several columns is able to carry out continuously the percolation process, for, if the adsorbent material in one column loses its bleaching power, the oil will be allowed to enter another column filled with fresh adsorbent material. The spent bleaching clay contains certain amounts of absorbed oil, which can be removed from the adsorbent material by means of hot water. The water flows from the bottom to the top of the column, displacing the adsorbed oil from the porous bleaching clay. To remove the rest of the oil, treatment with steam or proper solvent is necessary.

In refining lubricating oils that contain an appreciable quantity of paraffin wax the percolation process is virtually as follows: oil of low or medium viscosity may or may not be treated with sulphuric acid and neutralized with caustic soda solution, but oil of high viscosity commonly is not treated with acid because of the difficulty of separating the acid sludge. This is particularly true of Pennsylvania oils. The lighter lubricating oils are passed through the percolator at the predetermined optimum temperature and rate without dilution, but the more viscous oil commonly is first diluted with enough kerosene to give it sufficient fluidity for intimate contact with the adsorbent. After filtering through the granular earth, the light, undiluted lubricating oil is diluted for the first time, and the heavy, diluted oil is still further diluted with kerosene. The oils are then chilled, the crystallized paraffin wax separated, and steam distillation applied until the kerosene is removed and the lubricating oil reduced to the desired flash point. If the lubricating oil is diluted with kerosene before it goes through the percolator, less oil is left in the adsorbent than if the oil alone is percolated through the adsorbent. Kaufman[6] has studied the percolation process of cylinder oil diluted with naphtha. He filtered the oil through granular Fuller's earth, distilled out the naphtha and reduced the oil to the desired flash point. The first oil coming through the filter showed very marked changes in temperature, specific gravity, pour point, carbon residue, iodine number, and sulphur content, but the last oil coming through showed little change.

As mentioned, the length of the column that is filled with adsorbent material plays an important part in the percolation process. This characteristic causes many technical and economical inconveniences; each sort of oil requires a column of different length, necessitating construction of several columns of different height.

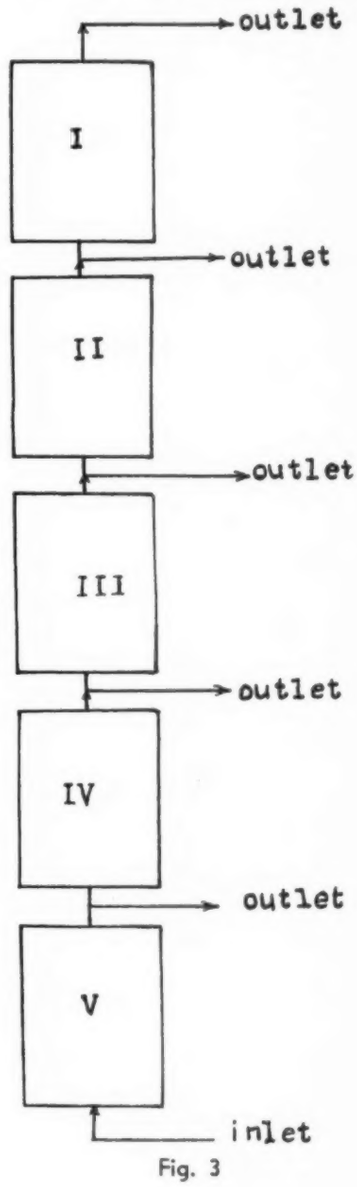

Fig. 3

During the writer's practice in the refining industry he constructed a new type of percolator that he believes has given better results than types formerly used (Fig. 3).

A series of little cylindrical columns placed one after another is used instead of a very high column, which would be very inconvenient to charge with the adsorbent material and would cause difficulty in controlling the flow during filtration. This construction permits the use of any desired length percolator. For instance, the oil enters the bottom of column V, and at the top the bleaching of the oil can be noted. If the oil is not completely decolorized, it can be directed to column IV. This process can be continued until the oil is decolorized to the desired extent. In addition to this advantage, this percolator can be used for refining oils of different sorts, that is, in the first run an oil can be filtered through four columns and in the second run a quite different sort of oil can be filtered through six columns.

The refiner employing the percolation process is faced with the choice of several commercial granular earths of various properties. The selection of an adsorbent should be made on the basis of true worth in the refining process. Inattention to this consideration has sometimes led to excessive filtering costs because of the selection of an inferior material. The following characteristics of the several earths should be determined:

1. Initial percolation efficiency.
2. Efficiency of regeneration.
3. Characteristics of the earth in the washing and steaming operation.
4. Volume weight relationship.

Relative value of these products can be determined in the laboratory and should narrow the selection. It is usually wiser to make the final ratings on the basis of plant scale operation, because of the fact that greater differences in regeneration will obtain in the plant due to more severe burning conditions. Comparison of competitive clays should be made on samples of equal mesh size. Yields should be calculated on a clay weight basis. Percolation evaluation should be made using equal volumes and filter height of the clay.

The technical control of plant filter operation should be based upon definite standards established for the individual stocks by preliminary laboratory investigation. These standards should include the following factors:

1. Clay-oil contact time.
2. Optimum temperature of filtration.
3. Operating time schedule.
4. Steam, solvent, and air requirements for washing, together with specified method of washing.

Before processing a given oil in the percolator, a laboratory study should be made to establish the optimum time of contact and temperature of percolation necessary to obtain the desired product quality. Having established the optimum, limitations of plant equipment, such as maximum allowable pressure and temperature, together with consideration of throughput requirements, will in general determine whether the best conditions can be obtained and, if not, how closely they can be approached. The success of any studies of percolation processes in the laboratory depends upon close correlation between plant and laboratory results and the reproducibility of results.

In comparing different grades of the same clay, for example 15/30, 15/60, 30/60, and 60/90 mesh samples, rate adjustment should be made to insure at least equal time of contact of clay and oil during the test. In the percolation of a specific stock for which optimum operating conditions are known, the time of contact permitted should approximate as closely as possible standard filter time on the material.

The temperature at which different oils should be filtered is determined from standard plant practice on the material in question. As mentioned, temperature depends upon the composition of the crude. In general the temperature of percolation of cylinder oils is approximately 220 deg. fahr., but Pennsylvania stock should be filtered at approximately 350 deg. fahrenheit. We are forced to the conclusion that oils of naphthenic or paraffinic base may be submitted to higher temperatures, not to exceed 350 deg. fahr., whereas oils of unsaturated base must be percolated at moderate temperatures.

It is often found desirable to increase filtering rates in plants having limited filtering capacity. If the oil to be filtered is undiluted, this can be accomplished by using a coarser mesh clay. It is known that under similar conditions of pressure and temperature, a greatly increased rate of flow can be obtained through the coarser mesh clays compared to that through the finer mesh clay; however, the yield-rate-temperature relationship is so widely different for various charging stocks on the different mesh clays that requirements should be determined for individual cases.

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[1]U. S. P. 1, 435,972.
[2]U. S. P. 1, 752,709.
[3]U. S. P. 1, 695,251.
[4]U. S. P. 1, 585,922.
[5]U. S. P. 1, 581,370.
[6]Refiner and Natural Gasoline Mfr., 1928, No. 4.

Ample Supply of Synthetic Rubber Now Available From Petroleum

AN ample supply of synthetic rubber can be made from natural gas and gases from the cracking of petroleum if during war time the United States should be cut off from the sources of crude rubber abroad, according to information reaching the American Petroleum Institute. This great contribution to national defense is one of the many strides made since 1929 in the utilization of petroleum to meet the needs of an expanding civilization. Thousands of tons of synthetic rubber now are being produced annually in this country.

Principal among the merits of synthetic rubber derived from petroleum sources are: (1) it does not swell and deteriorate when used for gasoline and oils, and (2) it resists the corrosive action of electric currents. Synthetic rubber has proved so satisfactory that fuel lines in some modern automobiles are made from the new substance. When manufacturers streamlined the rear end of cars, the use of synthetic rubber permitted the filler neck of the gasoline tank to be transferred to the left rear fender. All motor fuel hose on U. S. Army planes are now made from synthetic rubber.

Because this new product of American ingenuity is not easily injured by air, moisture, sunlight, or electric currents, nor by oils and greases, it is finding wide use as an insulating material for electric wires and cables.

Synthetic rubber is manufactured from ethylene dichloride, a substance derived from petroleum sources, and from sodium polysulphide. It is what chemists term a "condensation product." When two or more substances are mixed, sometimes the molecules of the substances rearrange themselves, or condense into new molecules, to form an entirely new substance.

Like many other important scientific discoveries, synthetic rubber from ethylene dichloride was made by accident. Approximately 15 years ago a chemist was experimenting to find a cheap and effective anti-freeze for automobiles. When he mixed the dichloride and the polysulphide together a gummy mass was formed that looked and acted like rubber.

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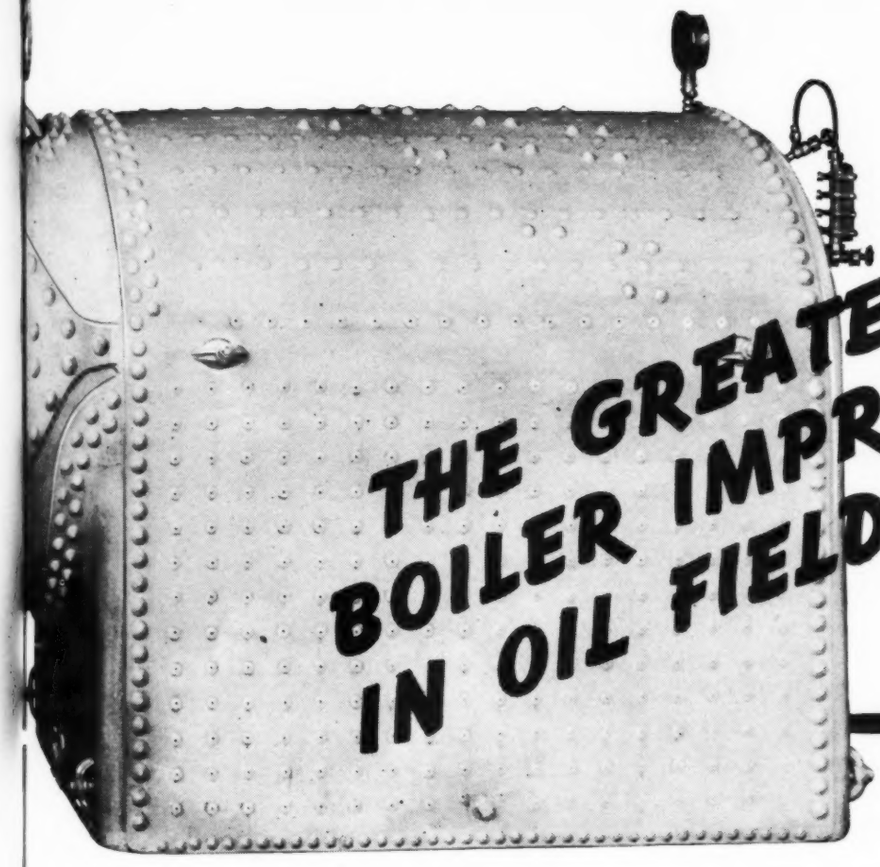

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The gravel is allowed to flow into the lubricator through the funnel and when one lubricator is full the process is repeated on the other side to fill the other lubricator. Continuous flow of gravel down the well thus is obtained

By

WALLACE A. SAWDON
Petroleum Engineer, Los Angeles

Part 2

Well conditions determine the method to be used for introducing gravel into wells

Gravel-Packing Oil Wells

METHODS OF PLACING GRAVEL

TWO general methods have been used for transporting the gravel from the surface to its position around the liner in the bottom of a well. The reverse circulation method, by means of which the gravel is introduced between the casing and tubing, the carrying fluid returning to the surface through the tubing, is the only one yet used in California (Figs. 1 and 2). The other, whereby the gravel and fluid are pumped down a string of tubing and out the bottom of the liner in the manner in which a cementing job is performed, has been used in the Mid-Continent and has been applied mainly to gravel-packing wells that have been producing for some time (Fig. 3).

Reverse Circulation Method

The first method has already been improved during the short time it has been in use, yet details in the technique still vary widely. As experience is gained, and ideas are exchanged between the various operators that are using gravel-packing to an ever-increasing extent, increased efficiency can be expected both in the methods of placing the gravel and in well equipment. A general description of various applications of the reverse circulation method indicates the progress made.

The gravel is carried in a mud fluid down the annular space between the casing and tubing and then between the wall of the open hole and the liner. The mud fluid is of low viscosity that will allow the gravel to drop readily but also will hold it up sufficiently to keep it from bridging before it gets in place. Some companies use no native mud but make the fluid from an admixture (such as Aquagel) and water. This mix has been found most satisfactory when it has a viscosity of 25 to 27 seconds with a Marsh funnel, 500 cc. in and out. A viscosity of 30 seconds is probably the average and such a mix consists of slightly more than four percent of the admixed solids by weight.

Looking down the cellar with the two lubricators shown behind the casing nipple. The man in the cellar operates the bottom valves on the lubricators. Royalty Service Corporation well

One of the first gravel-packed wells in a San Joaquin Valley field was completed in a low-pressure zone. In this well the gravel was merely dumped in between the casing and the tubing and allowed to fall to bottom. It was introduced in batches of one and one-half yards and each batch was followed by circulation until it was certain the gravel was in place. Before the operation was begun settling tests were made by watching the settling action of a sample of the fluid placed in a 500-cc. graduate. The mud used for circulation was like that already de-

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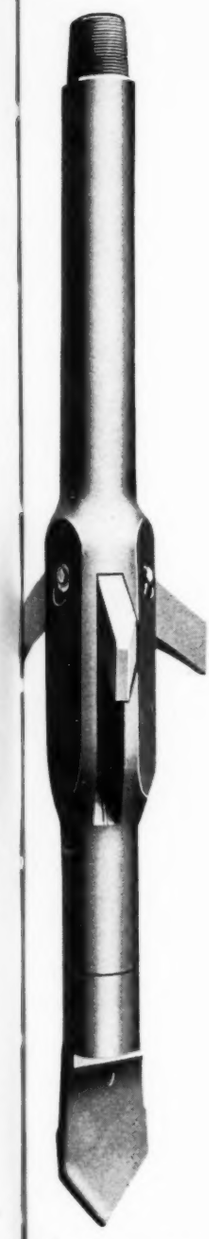

This MacClatchie Giant Wallscraper will readily pass through 11¾" casing, yet has a safe cutting capacity of 30".

Gravel Packing is THE big item of the day for increasing well production, and it is highly significant that the MacClatchie 3-blade Wallscraper is the overwhelming favorite for this process. Operators want its rugged strength and *3-blade* construction to assure *Positive Safety* when making the large cuts that are required. They recognize its 3-blade efficiency, safety and smoothness!

The MacClatchie Scraper distributes the cutting load evenly around the entire circumference of the tool, reduces the load per cutter, smooths out rotational strains, and assures an even cylindrical hole for the gravel pack. By spreading the load over three husky cutters, it assures:

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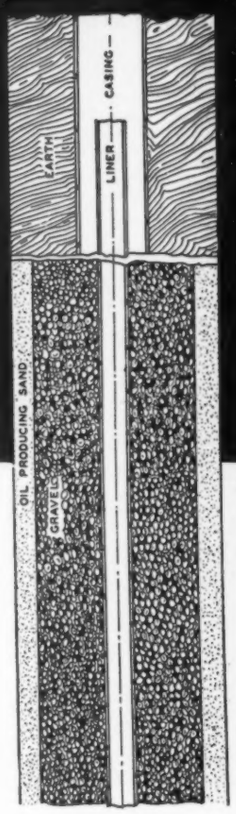
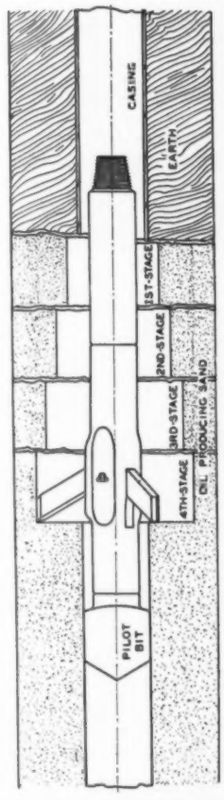


Gravel Packing requires a wide diameter of hole through the producing zone, and MacClatchie 3-blade Scrapers give the necessary safety for this type of work.



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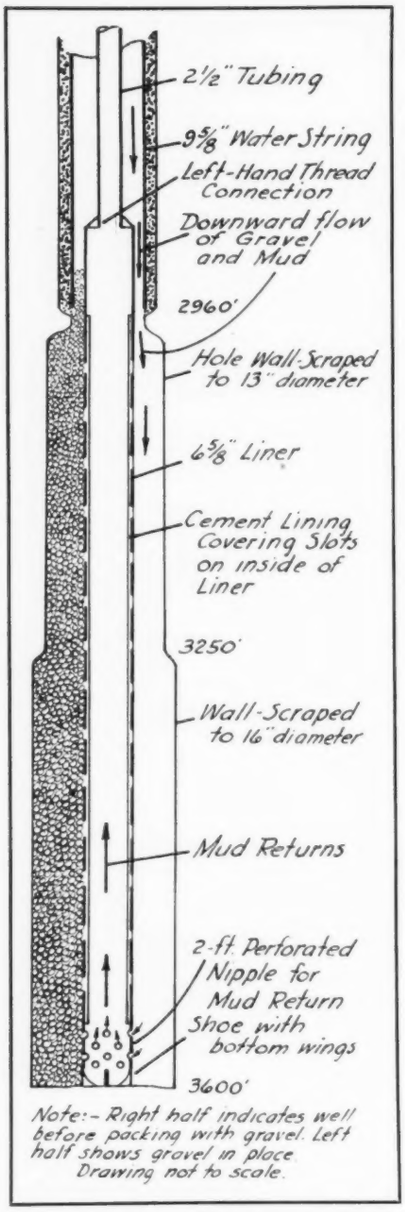

2½" Tubing
9⅝" Water String
Left-Hand Thread Connection
Downward flow of Gravel and Mud
2960'
Hole Wall-Scraped to 13" diameter
6⅝" Liner
Cement Lining Covering Slots on inside of Liner
3250'
Wall-Scraped to 16" diameter
Mud Returns
2-ft. Perforated Nipple for Mud Return
Shoe with bottom wings
3600'
Note:- Right half indicates well before packing with gravel. Left half shows gravel in place. Drawing not to scale.

Fig. 1. Showing the liner supported by tubing at its top and with passage for return of fluid provided by a perforated nipple just above the shoe.

scribed and weighed approximately 65 lb. per cu. foot. It picked up weight during circulation but the viscosity and weight were reduced by conditioning. The hole was wall-scraped and enlarged from 10⅝ in. to 20 inches. The gravel was probably a little larger than that generally used and was ⅜ in. to ¾ in. in diameter. In completing the well, it was merely put on the pump and no washing was found necessary, as the fluid used cleaned out readily.

In zones where the pressure is higher and where the well may flow, the gravel has to be lubricated into the annular space between the casing and tubing. Most companies have injected the gravel in batches, usually of five to ten cu. ft. each, and then pumped each batch down the well with the pumps running at high speed. Circulation is then continued for approximately an hour before lubricating in the next batch.

A method recently used in the Wilmington field employs two lubricators and provides for continuous injection of the gravel. The surface connections for the double-lubricator, continuous system are shown in Fig. 4 and are illustrated in the accompanying photographs. By the continuous injection method, 30 cu. ft. of gravel an hour were lubricated into the well. The pumps were run slowly at all times and the pressure on the circulating system never rose above 105 lb. per sq. inch. At this slow speed there is no washing effect. The well has since been brought in flowing naturally.

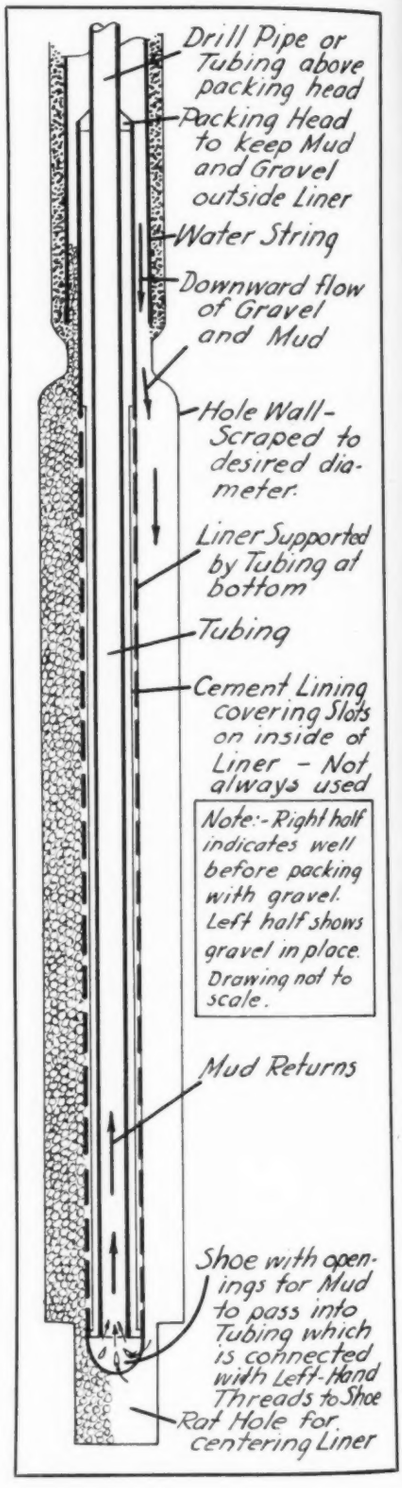
Two methods of providing for the mud returns are shown in Figs. 1 and 2. In the well illustrated by Fig. 1 the liner was attached to the end of the string of tubing by left-hand threads and lowered to rest on bottom. A cement lining in the liner covered the slots and forced the fluid to go to the bottom of the pipe, where it passed into the inside of the liner through a 2-ft. perforated nipple. The liner shoe was equipped with bottom wings to prevent its rotation when the tubing was unscrewed and pulled out of the well upon completion of the job.

In the well illustrated by Fig. 2 the liner was supported at the shoe by the tubing and was hung off bottom. The tubing was screwed into the shoe with left-hand threads and removed and pulled out of the hole after the gravel had been placed. The liner in this well also had a cement lining that covered the slots and caused the fluid to go to bottom and enter the tubing through openings in the shoe.

The liner may be centered at the bottom by means of a rat-hole, as shown in Fig. 2. The usual practice is to run the liner to the bottom of the rat-hole and then raise the shoe to a point just below the shoulder. Centering in the water string at the top generally is done by means of spring guides, care being taken not to offer obstruction to the passage of the gravel between the casing and that part of the liner rising above the casing shoe.

Cement (Howco) lining has been extensively used to close the slots while the gravel is being placed. The liner itself is not in direct contact with the cement as the lining is placed on a protective material that separates the cement and the pipe. The cement has to be drilled out after the gravel-packing job is completed. Other materials

Fig. 2. Illustrating a type of gravel-packing job in which the liner is supported by the tubing from its shoe; the fluid returns enter the tubing through openings provided in the plug. Centering of the liner is here done with a rat-hole.


Drill Pipe or Tubing above packing head
Packing Head to keep Mud and Gravel outside Liner
Water String
Downward flow of Gravel and Mud
Hole Wall-Scraped to desired diameter.
Liner Supported by Tubing at bottom
Tubing
Cement Lining covering Slots on inside of Liner - Not always used
Note:- Right half indicates well before packing with gravel. Left half shows gravel in place. Drawing not to scale.
Mud Returns
Shoe with openings for Mud to pass into Tubing which is connected with Left-Hand Threads to Shoe
Rat Hole for centering Liner

The BAKER ROTARY WALL SCRAPER

PIONEERED IN GRAVEL PACKING 6 YEARS AGO

BAKER ROTARY WALL SCRAPER

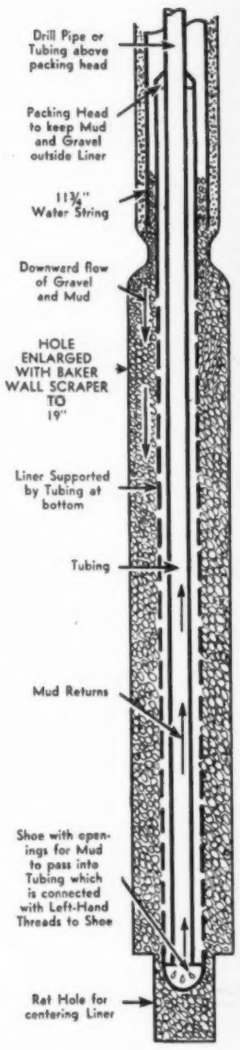
BAKER WALL SCRAPERS have been used for Gravel Packing for the past six years in completing water wells . . . ***and in oil wells.*** In fact, in 1931, the Baker No. 8 Wall Scraper, which has an expansion of 36 inches, was developed especially for Gravel Packing water wells, and soon after ***oil wells,*** and has since proved the ideal tool for this purpose.

AMAZING REAMING CAPACITY . . . One of the outstanding features of this remarkable tool is its great reaming capacity in relation to the size of the tool. It has an expansion range of from 4 inches to 36 inches, by using only six Wall Scraper Bodies. Tremendous strength, resulting from its correct design and the use of alloy steels, combined with minimum over-all dimensions, make it possible to run the tool through casing of comparatively small size, then to expand the blades and scrape the open hole below the casing to a large diameter.

A TOOL OF MANY USES . . . While Hole Enlarging for Gravel Packing constitutes an important modern application for the Baker Wall Scraper, it is only ONE of a number of OTHER equally important uses.

OTHER APPLICATIONS INCLUDE:

- You can bring in many a well more easily and in less time by scraping the rotary mud from the face of the oil sand.
- Scrape a wide shoulder as the first step in bringing a crooked hole back to vertical.
- Enlarge the hole to set a larger size liner.
- Insure water shut-off . . . by bottlenecking or enlarging the diameter of the hole above the point where the casing shoe will be positioned to provide ample space for cement entirely around the shoe and casing.
- When bottom water shut-off fails, wall scrape to size of original hole, or larger (after drilling out old cement) . . . then recement.
- Take actual core samples from the sidewalls of a previously drilled hole by substituting Core Sampler Blades for the regular Wall Scraper Blades.


Drill Pipe or Tubing above packing head
Packing Head to keep Mud and Gravel outside Liner
11¾" Water String
Downward flow of Gravel and Mud
HOLE ENLARGED WITH BAKER WALL SCRAPER TO 19"
Liner Supported by Tubing at bottom
Tubing
Mud Returns
Shoe with openings for Mud to pass into Tubing which is connected with Left-Hand Threads to Shoe
Rat Hole for centering Liner

A Typical Gravel Packing Job Showing Hole Enlargement Done With a Baker Wall Scraper.

BAKER GIVES YOU SAFETY AND RESULTS

The Safety of the Baker Wall Scraper has been demonstrated in thousands of successful runs made in oil fields throughout the world under the most difficult operating conditions. To our knowledge, no Baker Wall Scraper has ever failed to come safely out of the hole.

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BAKER ROTARY WALL SCRAPER ROTARY WALL SAMPLER

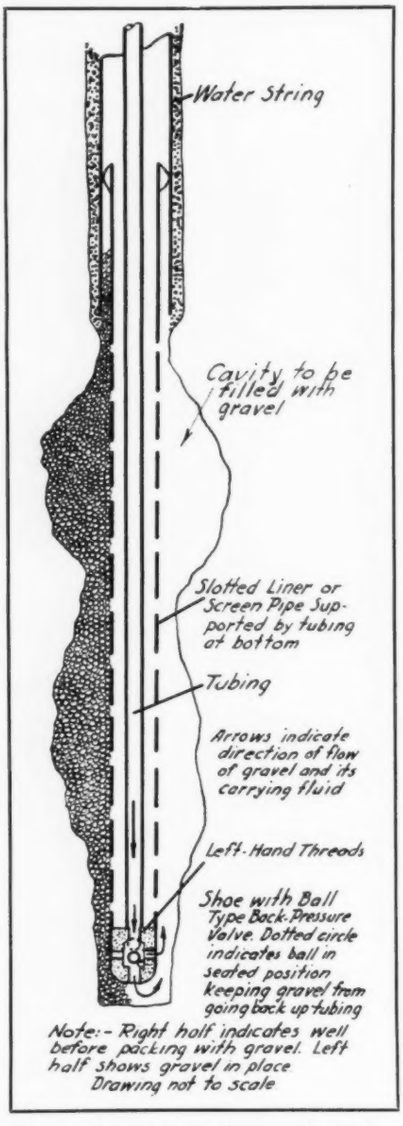

Water String
Cavity to be filled with gravel
Slotted Liner or Screen Pipe Supported by tubing at bottom
Tubing
Arrows indicate direction of flow of gravel and its carrying fluid
Left-Hand Threads
Shoe with Ball Type Back-Pressure Valve. Dotted circle indicates ball in seated position keeping gravel from going back up tubing
Note:- Right half indicates well before packing with gravel. Left half shows gravel in place
Drawing not to scale

Fig. 3. The method of gravel injection similar to cementing operations is here indicated.

for lining, such as some oil-soluble substances, have been considered. So far as known, however, none of these has been tried in the California fields.

In many wells gravel-packed as illustrated in Fig. 2, the cement lining has not been used. In some, in which slots are left open, the tubing has been equipped with swab rubbers or similar rubber devices; in other wells, the slots have been left open and no attempt made to divert any fluid entering the liner (if it does enter it) from the course it takes naturally. The use of inverted swab rubbers is illustrated in Fig. 5.

Theoretically, as soon as the fluid fills the space between the tubing and the liner, the pressure will be equalized and the mixture of gravel and fluid will continue downward under pressure outside the liner. Some operators think that the fluid may by-pass through the slots, causing formation of a bridge that will prevent the gravel from building up from the bottom. It is believed that the swab rubbers will localize any tendency to bridge and cause a dislodgement of any short bridge that may start to form. Whether or not swab rubbers or similar devices should be used when the slots are left open is a matter of opinion at the present time. They may become a hazard if something occurs to let the gravel into the liner and around the tubing.

A combination string from the surface to the bottom with the lower portion slotted or perforated probably can be gravel-packed with greater ease than a liner extending just above the shoe. The cost of such a string is greater than that of a liner, however, and most wells probably will be completed with liners.

The method of depositing the gravel in the well first and then forcing the liner through it has also been tried. The difficulty of forcing the liner to bottom, even when equipped with a chisel-point shoe, is evident. One company had to pull the liner during a gravel-packing job and had no difficulty in rerunning it. Normal circulation was maintained until the liner was lowered through the gravel, the jetting action of the fluid washing the gravel away as the liner was lowered. When the liner was back in place, circulation was reversed and the rest of the gravel lubricated into the well. The same procedure has been followed in raising and lowering the liner in a rat-hole, although if the distance is small circulation may not have to be reversed.

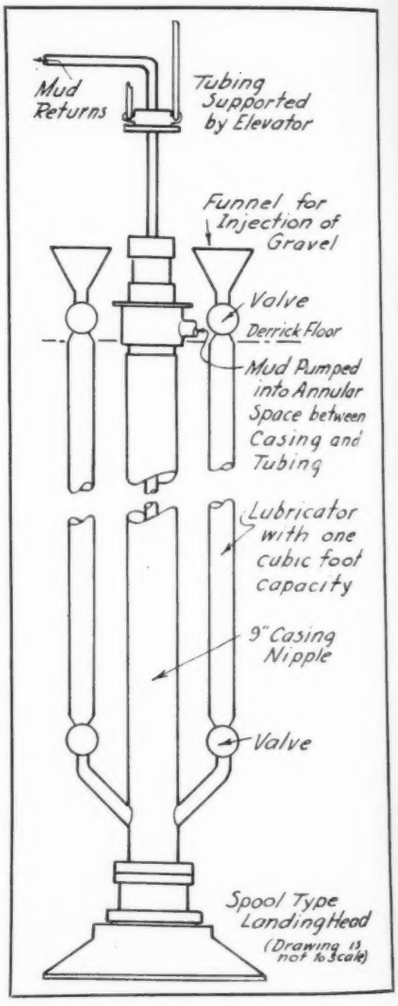
In gravel-packing old wells by the reverse circulation method in California the same procedure is followed as in completing new ones. No matter what the conditions, the holes were scraped through the sand, free passage provided for the gravel, and a gravel pack of desired thickness obtained.

Normal Circulation Method

The method of pumping the gravel down through tubing and up around the liner through the shoe has been used for gravel-packing old wells in the Oklahoma City field, as described by C. J. Coberly and E. M. Wagner in a paper entitled "Some Considerations in the Selection and Installation of Gravel Pack for Oil Wells" delivered at the A.I.M.E. meeting held in Los Angeles on October 1, 1937. This paper presents some valuable data on laboratory experiments performed to determine the proper size of gravel to use to retain certain formation sand grains. The paper deals with application of the method to wells producing from the Wilcox sand. Completed in open hole, these wells produced considerable sand during flowing and gas-lift periods and this resulted in the formation of large cavities around the bore. When placed on the pump, sand troubles continued with attendant pumping difficulties. Perforated liners with a mesh to hold the sand were impracticable because the bottom-hole pressure was as low as 20 to 50 lb. per sq. in. and production was very large.

In placing the gravel in the well an attempt was made to fill the cavities completely; and the method used put the gravel behind the liner from below to prevent formation cavings from filling the space. In this manner the gravel replaced any fluid in the hole in an upward movement. The gravel itself is carried by a fluid readily removable and in the Oklahoma City wells this fluid was an oil of a base similar

Fig. 4. This double lubricator hook-up provides for continuous injection of the gravel between the casing and the tubing.



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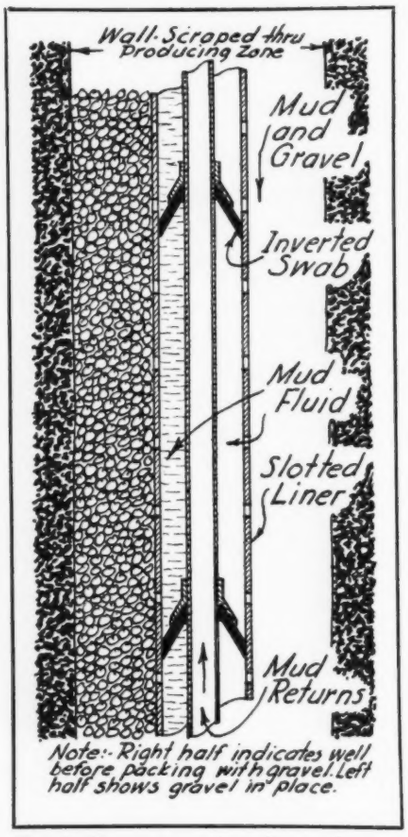
Wall Scraped thru Producing Zone
Mud and Gravel
Inverted Swab
Mud Fluid
Slotted Liner
Mud Returns
Note:- Right half indicates well before packing with gravel. Left half shows gravel in place.

Fig. 5. Some operators favor the use of inverted swabs when the slots are not sealed off as here shown.

to that of the oil produced by the well. The gravel and oil mixture was pumped by a slush pump in the same manner as cement slurry in a cementing job.

The general procedure is indicated in Fig. 3. The liner hung in the well is provided with a shoe containing a ball check valve and it is recommended that the liner be equipped with centering springs. The shoe is provided with left-hand threads into which is screwed the tubing through which the gravel passes. After the gravel-packing job is completed the tubing is unscrewed and what gravel mixture is left inside the liner is bailed out.

It is the opinion of the writer that the normal circulation method, which so closely resembles cementing practices, will come into greater vogue both for newly-completed wells and for repair work under certain conditions. Trouble caused by the pumping of a mixture of gravel may partially offset the advantages of this method.

Gravel

The gravel used for gravel-packing should be clean. It is the usual practice to screen it before use. For injection into the well by the reverse circulation method, the sizes used in California probably have averaged ¼ in. to ⅜ inch. Some gravel has been as large as ¾ in. but there seems to be a tendency to restrict the size to ½ in. or less. The gravel used in the direct circulation method is much smaller and in the Oklahoma City wells was 0.093 in. to 0.131 in. in diameter.

Greater attention will probably be paid in the future to size of gravel, its relation to the size of grains of which the formation sand is composed, and the relative value of uniform and mixed sizes. Screen pipe liner openings certainly can be larger if gravel is used than if gravel is not used. There is, of course, a relationship between the size of gravel and the size of opening in the screen just as there is between the grain sizes of the gravel and the formation sand. It appears, therefore, that the formation will be the important factor in determining the size of gravel to use and the size of liner opening that best will retain the gravel that will have to be used. Every producing area should be studied before any selection of gravel or liner is made; and with the further development of methods, the one best suited for placing the gravel in the well should also be given careful study.

Already some companies are considering the possibility of using centrifugal pumps for injecting gravel into the well. Such pumps will have to be specially designed for the purpose but they may be applicable to both reverse and direct circulation methods. Producing conditions, pressures encountered, and other factors, in addition to the character of the sand, will all have their bearing on the methods and equipment used.

The matter of estimating the amount of gravel will always be a problem. In the completion of new wells a rather close estimate may be made, as shown by one Wilmington field well from which the amount of gravel left over was less than a yard. Whether cavities are completely filled with gravel or not can only be guessed.

New Oil Tankers Powered by Late-Type Equipment

GEARED turbines have been used for the propulsion of two oil tankers, S.S. Gulfcoast and S.S. Gulftide, which have been placed in service by the Gulf Oil Corporation, and duplicate turbine equipments will be used for two similar tankers built or being built for the same company by the Bethlehem Shipbuilding Corporation. The propelling units have a normal rating of 2800 hp., 78 r.p.m., with steam conditions of 375 lb., 700 deg. fahr. total temperature, and 1¾-in. absolute back-pressure, states Guy Bartlett, of the General Electric Company, in writing of developments in the electrical industry during 1937.

The turbine rotors are solid-steel forgings. The design of the turbine is original in that the low-pressure base and lower half of the exhaust casing are integral and carry the full weight of the condenser shell. Installation is thereby simplified, and likelihood of stress resulting from rolling and pitching of the vessel is negligible. The exhaust casing for the low-pressure turbine and the supporting platform are a unit of fabricated construction.

The high-speed gears, of cast steel, are 55.82 in. in diameter and have a 13-in. active face. They operate with a pitch-line velocity of 10,540 ft. per min., practically two mi. per minute. The low-speed gear is of the fabricated type, having forged-steel shaft and web plates for supporting the rim. These plates are welded to the cast-steel hub and rolled-steel rim. The low-speed gear is 114½ in. in diameter and operates at a pitch-line velocity of 2340 ft. per minute.

The highest pressure and temperature yet used on any ship built in the United States will feature two turbine-electric-drive tankers being built for the Atlantic Refining Company by the Sun Shipbuilding and Dry Dock Company. The first tanker, the S.S. J. W. Van Dyke, will have its trial run early in 1938. Steam conditions are 600 lb. gauge, 825 deg. fahr. total temperature, and 1½-in. absolute back-pressure. The propulsion motor is rated 5000 hp. at 90 r.p.m., and the main 4500-kw. turbine generator supplies power not only for the propelling motor but also for the auxiliary motors and lights at sea. Three 300-hp. cargo pumps on each tanker are driven by 2300-volt explosion-proof motors.

Another oil tanker, being built by the Sun Shipbuilding Company for the Tide Water Associated Oil Company, is being supplied with a 3600-hp. geared turbine.

Remember your first ride?

FIVE BUCKS **against a plugged nickel** **the first time you tried to ride a bicycle you fell off.** **Today most men learn to fly** **before they buy a plane.** **The Lane-Wells Company believes that before it sells packers** **the applications of these packers** **should be sold. That Lane-Wells "Multiple Ring"** **Packers never stick, that they provide a positive seal off,** **that they are easy to remove,** **regardless of the length of time** **set, is of less importance than where** **and when** **packers may be profitably** **used. This bulletin** **gives full information on packer applications.**

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Technical Oil Field Services

Running Tour
WITH MEN IN THE INDUSTRY

DR. J. H. SAWYER recently arrived in Colombia, South America, to take charge of geophysical explorations for the Shell Group.

E. K. RIDEAL, professor of colloid science in the University of Cambridge, England, has been made adviser on physical and colloid chemistry by the Anglo-Iranian Oil Company.

S. C. MACKENZIE, field manager of the Uganda oil search of the African and European Investment Company, Ltd., has returned to the field after being in London since early in October.

P. ANGOT, general manager, and **R. PLESOIANU,** chief engineer, of Steaua Romana Oil Company of Bucharest, Roumania, recently made a tour of Mid-Continent and California oil fields.

R. E. ADAIR, petroleum engineer for the Texas Railroad Commission in the Marshall area of East Texas, has resigned to join the engineering staff of the American Liberty Oil Company. His headquarters will continue to be at Marshall, from which point he will look after the company's activities in the Rodessa field.

ELMER R. CORN, Wichita, Kansas, president of the Plains Oil Company, has been elected a member of the city commission to complete the unexpired term of Senator Frank Nighswonger, who died recently.

J. O. SEHON, formerly district electrical foreman at Dickinson, Texas, for the Humble Oil and Refining Company, has been transferred to the Conroe, Texas, district.

J. L. INGRAM, who has been a consulting engineer in the Lubrication Department of the Barnsdall Oil Corporation, Tulsa, Oklahoma, has resigned to join the staff of the Ohio Oil Company. He is covering the southwest territory for the latter company and is making his headquarters in Fort Worth, Texas. The Lubrication Department of the Ohio Oil Company is giving a free engineering service to its customers and prospective customers.

S. G. COULTIS, who has been field superintendent for the Royalite Oil Company, Ltd., in the Turner Valley field, Alberta, Canada, has been placed in charge of the pipe line division of the company.

JOHN F. CONWAY, who has been in Argentina with the Standard Oil Company, is now in charge of production for the European Gas and Electric Company. His headquarters are Bucharest, Roumania.

J. F. FABER has retired as superintendent of the Standard Oil Company of California's refinery at Bakersfield. He has been 35 years with the company.

DR. F. B. THOLE, deputy chief chemist of the Anglo-Iranian Oil Company, London, has recovered from a recent operation. He left London recently for a trip to Iran.

E. E. SWOPE, vice-president and general manager of refineries for the Magnolia Petroleum Company, died from a heart attack on December 12 at his summer home at Lake Arthur, Louisiana. He had been a member of the Magnolia organization since 1917, advancing from refinery engineer to manager of the department. **JOHN W. NEWTON,** who has been assistant manager of refineries, becomes the new vice-president and general manager.

THOS. H. ALLAN, petroleum engineer and geologist, has opened an office at 707 Bitting Building, Wichita, Kansas, and will devote his time to consulting work.

ALBERT WRIGHT, for more than 11 years with the Venezuela subsidiary of the Gulf Oil Corporation, has been appointed general superintendent of the Amiranian Oil Company. His office in New York City will be at 39 Broadway.

H. D. HUMPSTONE, manager of the West India Oil Company, the Standard Oil Company of New Jersey's subsidiary in Chile, South America, left the United States to return to his duties the latter part of December.

F. A. C. GUEPIN has been appointed executive vice-president of the Shell Oil Company, having his headquarters at San Francisco, California. The announcement was made by **S. BELITHER,** president of the company. Guepin goes to San Francisco from New York City.

JOHN E. CALHOUN, Jr., has been appointed to the water-flooding research staff of Pennsylvania State College. He was graduated from the college last June, having specialized in petroleum engineering and mineralogy. Prior to accepting his present position he was associated with the Shell Petroleum Corporation at Tulsa, Oklahoma, as a petroleum engineer.

FRANK SEELY, general superintendent of the Royal Oil and Gas Company in the Texas Panhandle district, has been transferred to Tulsa, Oklahoma, and placed in charge of operations in Texas, Oklahoma, Louisiana, Kansas, and Arkansas.

T. H. ANDREWS, Houston, Texas, division engineer in the Gulf Coast area for the Stanolind Oil and Gas Company, has been made district superintendent, succeeding **GILBERT PRINCE,** resigned. **CHARLES F. BEDFORD,** Houston, petroleum engineer, is the new division engineer.

MARVIN C. ROGERS, chemical engineer in the research laboratory of the Standard Oil Company of Indiana, Whiting, Indiana, recently was appointed assistant professor of chemical engineering at the University of Minnesota.

T. W. HERRIN, field superintendent at High Island, Texas, for the Stanolind Oil and Gas Company, has been transferred to Lake Charles, Louisiana, where he is district superintendent. **E. D. MASKE,** field superintendent at Barbers Hill, takes over Herrin's vacant post, and in turn has been succeeded at Barbers Hill by **L. L. CHISHOLM,** who has been in the East Texas field.

REESE H. TAYLOR, president of the Consolidated Steel Corporation, Ltd., has been elected a director of the Union Oil Company of California.

•After all, no matter how good his intentions may be, a salesman's promise of tanks for next week won't hold oil today. That's why we carry a complete stock of tanks in every active field . . . and by the same token, why so many operators in fields all over the country depend on this combination of quality tanks and "on the spot service".

If *you* are not already acquainted with Parkersburg Tanks why not call our representative in your field for complete details and prices. They are made in all sizes up to 10,000 bbls. capacity . . . either painted or galvanized finish. Then, next time you need tanks in a hurry, give him the pleasure of showing you why it is good business to depend on Parkersburg.

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LAUGH WITH BARNEY

Edited by BARNEY HORRIGAN

Visitor: I suppose they ask a lot for the rent of this sumptous apartment.

Hostess: Yes, they asked Harold seven times last month.

* * *

The question of the correct plural of the word "mongoose" was solved by a gentleman who wanted a pair of these interesting and affectionate creatures.

He wrote to a dealer: "Sir, please send me two mongeese."

He did not like the looks of this, tore up the paper, and began again: "Sir, please send me two mongooses."

This version did not satisfy him any better than the other, so he wrote: "Sir, please send me a mongoose, and, by the way, send me another."

—*Punch Bowl.*

* * *

One of the questions asked in a civil service examination in New York City recently was the following:

"If a man buys an article for $12.25 and sells it for $9.75, does he gain or lose by the transaction?"

One of our modern sweet things, probably with good looks unmarred by brains, after studying for awhile, is said to have given the following answer:

"He gains on the cents, but loses on the dollars."

* * *

A man was applying for county relief and the young lady official was filling out the customary form.

"Do you owe any back house rent?" she asked.

"I should say not," he replied. "We have modern plumbing."

* * *

Mistress: Your young man has an air of braggadocio about him, Mary.

Mary: Yis, pore lad, he wurruks in a livery stable.

* * *

She: What would the neighbors think if they saw me on the stage in tights?

He: They would think that I married you for your money.

—*The Yellow Stand.*

* * *

Mrs. Crimsonbeak (at the head of the stairs): How you frightened me, John!

Mr. Crimsonbeak: Why?

"Oh, you found the keyhole so quick I was afraid it was somebody else."

First Student (as plane goes into spin): "Quick, what do I do now, instructor?"

Second Student: Hell's bells, aren't you the instructor?

* * *

"Where'd you get the money?"

"Playing a horse."

"Where, Saratoga?"

"Naw. In vaudeville."

—*Penn State Froth.*

* * *

"Is a ton of coal very much, Papa?"

"That depends, my son, on whether you are shoveling or buying it."

* * *

"He was kicked out of school for cheating."

"How come?"

"He was caught counting his ribs in a physiology exam."

* * *

Worried Telephone Subscriber: I say, my telephone hasn't been working for a month, and you paid no attention to my letter of complaint.

Irish Official: We did. We rang you up to ask what was wrong and got no answer!"

* * *

Sign in a book store in Scotland in July: Buy your gift books now so you may finish reading them by Christmas.

* * *

Cause and Effect

"Dear Tom:

"Come tomorrow evening sure. Papa is at home, but is laid up with a very sore foot. See?" "May."

"Dear May:

"I can't come tomorrow evening. I'm laid up on account of your father's sore foot. See?" "Tom."

—*Mercury.*

* * *

"You see, sonny, I always believe in fighting the enemy with his own weapons," said the uncle.

"Really?" gasped Tommy. "How long does it take you to sting a wasp?"

* * *

An electrician was working on an emergency wiring job. Turning to the apprentice who was helping him, he said, "Say, Bill, take hold of the end of that wire."

"All right."

"Feel anything,"

"No."

"Well, then, don't touch the other one, it's got over 5000 volts."

Widow: I want to insert an obituary notice in your paper. How much will it be?

Editor: Twenty-five cents an inch, madam.

Widow: Oh, land sakes, and John was six feet tall!

* * *

An inventor manufactured a gas-saving device so efficient that its users had to stop every fifteen miles and drain their tanks to keep them from overflowing.

* * *

Enterprise

"Almost every man can find work if he uses his brains," asserted the man who had traveled a good deal, "that is, if he has the ability to adapt himself like the piano-tuner I once met in the West of America.

" 'Why,' I said to him, for we were in a wild, unsettled country, 'surely piano-tuning can't be very lucrative here. I should not imagine that pianos were very plentiful in this region.'

" 'No, they're not,' said the piano-tuner, 'but I make a pretty fair income by tightening up barbed-wire fences!' "

* * *

"Ma! Ma! A big truck just ran over Pa and squashed him all over the street!"

"Junior, how many times have I told you not to talk about such things when I'm eating?"

* * *

And Complicated

"I was talking with somebody about you the other day. I've forgotten who it was, but I think she knows you, although I can't be sure because neither of us could quite remember your name."

"Say, it's a small world, isn't it?"

* * *

Uncle: You boys of today want too much money. Do you know what I was getting when I married your aunt?

Nephew: No, and I'll bet you didn't, either.

* * *

A colored preacher at the close of his sermon discovered one of his deacons asleep. He said, "We will now have a few minutes of prayer. Deacon Brown, you lead?"

"Lead?" said Deacon Brown, suddenly awakening, "I just dealt."

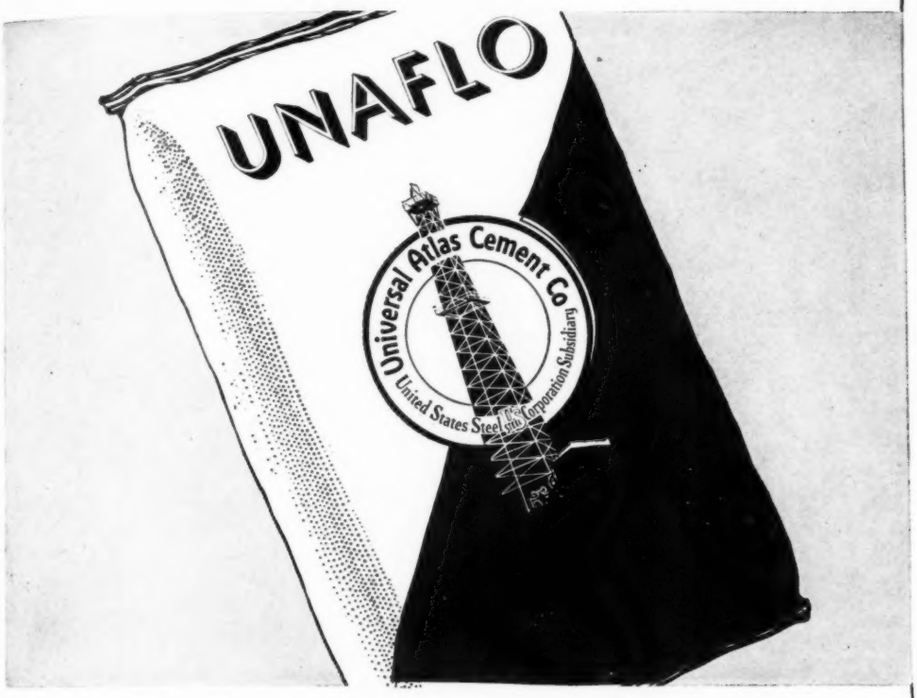
* * *

Yachtsman: If this squall continues, I shall have to heave to.

Girl Passenger: What a horrid way to put it.

NEW WORLD'S RECORD

in oil well cementing!



1500 bags of Unaflo cement pumped 11,342 feet with maximum pressure of 1400 pounds per square inch

Here are the quick facts on the most outstanding oil well cementing job to date—

Total depth of well—11,342 feet. Bottom hole temperature—236° F.

1500 bags of Unaflo mixed 15.8 pounds per gallon with two Halliburton trucks.

Mixing time—35 minutes.

Pumped down with two 20″ slush pumps (6″ liners). Pumps not compounded.

Pump-down time—18 minutes and 15 seconds.

Plug landed with maximum pump pressure of 1400 pounds per square inch.

No ice used.

Cement drilled from plug was hard and dense.

These low pump pressures signify:

1. Unaflo cement retains fluidity at highest known oil well temperatures.
2. Unaflo cement goes into place as a fluid cement slurry.
3. After it sets up, Unaflo slurry forms an impermeable seal against migrating subsurface fluids.
4. Unaflo cement is the economical oil well cement.

Try it on your next job!

UNIVERSAL ATLAS CEMENT CO.

United States Steel Corporation Subsidiary

AMICABLE BLDG., WACO, TEXAS; KANSAS CITY; TULSA; OKLAHOMA CITY

A Cement for Every Oil Company Use at Oil Well, Refinery and Filling Station

Atlas portland cement for *surface* work and for cementing *surface* casing. Unaflo cement is recommended for *deep* well work.

Lumnite cement is used in Oil Refineries for making Refractory, Insulating and Heat-Resistant Concrete Linings in Still Furnace Walls, Bottoms, Roofs, Foundations; Ducts, Flues and Stack Linings; Tube Sheet Insulation.

Lumnite cement makes Corrosion-Resistant Concrete and Mortar Lining in Distillation and Cracking Units; Re-Run Stills; Absorption Systems; Chemical Treating and Ethyl Plants.

Atlas White the cement that is pure *white* and non-staining. Exceeds specification requirements for portland cement strength. Ideal for ornamental work in connection with service station construction and repair.

U-16

USS

Universal Atlas
CEMENTS

MACHINERY and EQUIPMENT

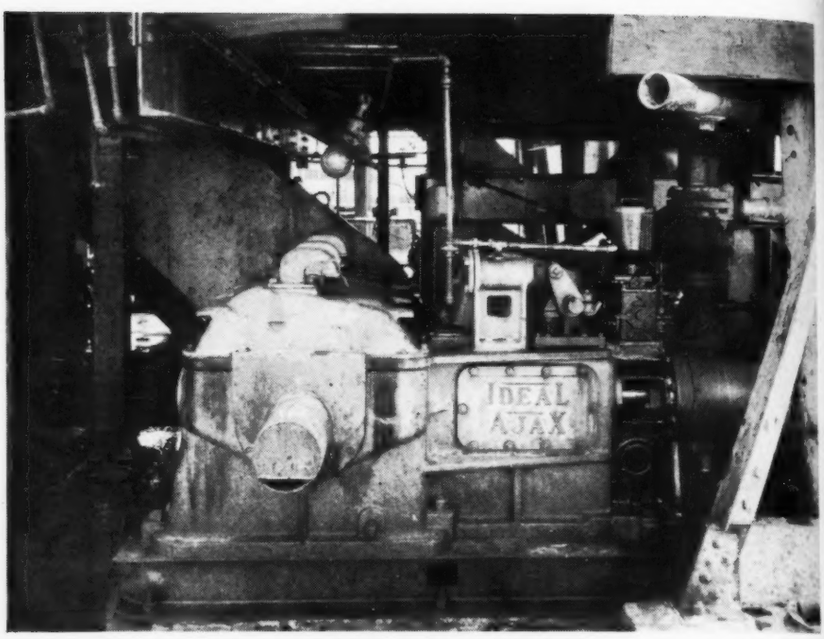
One-Piece Asbestos Suit

JOHNS-MANVILLE, New York City, has developed a new one-piece asbestos suit that is said to offer many new features for the protection of fire fighters. With the shoes and body of the garment all in one piece, the suit is an improvement over the former jumper jacket type, the manufacturers claim, as in an emergnecy it can be put on quickly by simply closing the zipper fastener up the front. Protected from the heat by a special asbestos flap, the zipper also permits a man to be removed from the suit quickly if he is overcome by heat. The suit permits maximum freedom of action.

For rescuers who take grave risks in attempts to save human life, Johns-Manville has attached a safety hook to the belt line of the new suit, and to this hook a flexible steel cable can be

attached to pull the rescuer away from a fire if he is overcome by heat.

Another feature of the new asbestos suit is the heat-proof glass that is suspended from the vizor of the hat and therefore stands clear of the face. Also, as the suit is made in one piece, the possibility of losing or misplacing necessary parts of the equipment is minimized.



Type "B" Underfloor Drive

RECENTLY The National Supply Company, Toledo, Ohio, introduced to the oil country a departure in the method of driving the rotary table. Their new Type "B" Underfloor Drive is an independent drive that eliminates the former conventional drawworks drive by driving the rotary table with a separate 9 by 8 steam engine placed below the derrick floor.

The advantages resulting from this arrangement are manifold, the manufacturers point out. One of the chief features is the elimination of the rotary drive chain across the derrick floor, giving more clear floor space and greater safety. There is less wear on the drawworks and on the hoisting engine when this underfloor drive is used, also better control over drilling operations, less noise, and greater economy, it is stated.

The photograph above shows an underfloor view of the Type "B" direct-rotary drive. This drive has been successfully used in drilling some of the deepest wells and has been enthusiastically received by all the operators concerned, the makers state.

The Type "B" drive places the 9 by 8 twin steam engine, with countershaft and rotary machine drive, below the derrick floor. The engine has a direct-coupled shaft extension on which clutch sprockets are mounted for driving the rotary machine and countershaft. The countershaft is placed under the drawworks and provides a means of transmitting the power of the 9 by 8 engine to the drawworks in an emergency, or using the hoisting engine to drive the rotary machine. The chain drive to the rotary machine is enclosed in an oilbath guard. With this drive a power take-off is provided for driving an auxiliary or standby hoist. This is accomplished by placing a sprocket on the opposite end of the engine shaft.

The Ideal-Ajax 9 by 8 steam engine used on this drive is a new all-purpose oil-country engine, suitable for drawworks drive and direct-connected pump drives, as well as for direct-rotary drive.

† "COMBAT"—by Charles M. Russell

Combat

One word, but it sings the saga of life—the story of nations—of people—and of industry. Nations war for territory—for supremacy—companies combat to hold today's business—to build new. ☆ To the winner belong the fruits of victory, but the winner must be strong, wise and experienced. Manufacturers have learned that in industrial competition—research, engineering, design and manufacturing perfection are weapons of the winner. They have learned that with these company attributes products are fabricated that in themselves combat the destructive efforts of Nature and of Man. ☆ Axelson Pumps and Sucker Rods are such products. ☆ Axelson Manufacturing Company, P. O. Box 98, Vernon Station, Los Angeles. St. Louis. 50 Church Street, New York. Tulsa. Mid-Continent and Eastern Distributor: Frick-Reid Supply Corporation. Rocky Mountain Distributor: Great Northern Tool & Supply Co.

☆ ☆ ☆

† Charles M. Russell—a great artist of a great country. He knew and loved the creatures of the West. His rare ability to portray an accurate and artistic record of the lives of Western wild life is shown in this bronze of the two "Big Horns" in deadly combat. He caught all the power of this battle to the death and immortalized it in bronze. This is the first time that permission has been granted for reproduction of this bronze. A reproduction of this picture, suitable for framing, is available upon request.

AXELSON PUMPS AND SUCKER RODS

Pump Manifold Valve

A NEW pump manifold valve, designed and manufactured by the American Iron and Machine Works Company, Oklahoma City, Oklahoma, affords increased efficiency and safety, according to the manufacturers.

The valve is designed to be installed next to or as near the air chamber as possible. It has an easy opening, fast threaded screw to permit quick opening and closing, and is constructed with a lock nut so the valve can be locked when closed, open or at any desired position. The valve can be opened to permit the desired flow and locked, this feature allowing the circulation and mixing of mud at the same time. A ball-bearing swivel joint is used in the center of the control stem so that the valve does not turn and cause friction against gritty fluid when seating. Also, the valve is packed so the stem is automatically sealed when open, and is so constructed that the inner stem gland may be repacked under pressure when in open position. It can be repaired without removing from the line; if the steel seat becomes worn it can be replaced without discarding the entire valve, claim the manufacturers.

Hercules Adds 2-Cylinder Gasoline Engines to Line

THE Hercules Motors Corporation of Canton, Ohio, in announcing the "NX" series engines and power units, has added two models of 2-cylinder, heavy-duty gasoline engines and power units to its present line of well-known 4- and 6-cylinder gasoline and Diesel engines. The internal dimensions of the "NX" series are as follows:

Model	*Bore*	*Stroke*	*Displacement*
NXA	3	4	56.5
NXB	3¼	4	66.3

These two engines are identical in general design and most of the parts are interchangeable, the only difference being in the bore size and the parts affected thereby. The maximum torque of the "NXA" is 39 lb-ft. at 1100 r.p.m., and the maximum torque of the "NXB" is 46 lb-ft. at the same speed. For continuous peak load service both models can be operated up to 1800 r.p.m., at which speed the "NXA" develops 12.4 and the "NXB" 14.7 corrected horsepower.

To meet present-day conditions, which call for sustained high-speed operation, special consideration has been given to the cooling of the valves, and the usual Hercules practice of cooling the valves through the stems is employed. Updraft manifolds of either the center- or rear-outlet-type can be supplied. The No. 5 SAE bellhousing is supplied as standard equipment on the engines and the industrial power units, although the No. 4 size can be provided upon request.

Full, force-feed lubrication to all main- and connecting-rod bearings is supplied and the lubricating pump is situated in the oil sump and is driven by helical gears from the main camshaft. Oil pressure can be easily adjusted to suit the operating requirements.

The crankcase is cast integral with the cylinder block, and carries the crankshaft supported by two main bearings of ample proportion. These bearings are 2 in. in diameter, the front bearing is 1-9/16 in. long, and the rear bearing 1⅝ in. long. Connecting-rod bearings are 1¾ in. in diameter and 1⅛ in. long, connecting rods being 6-9/16 in. in length from center to center.

The pistons normally are of cast iron, carrying three rings above the pin. The lower of these rings is of the oil-regulating type, being 3/16 in. in width, whereas the two upper rings are of the compression type, ⅛ in. in width. The piston pins are of 1020 SAE McQuaid Ehn tested steel ¾ in. in diameter. Each pin is securely locked in its connecting rod by means of a clamp bolt and operates in two hard-cast bronze bushings in the piston. Aluminum pistons also can be supplied. The camshaft is supported in two main bearings of ample size, and is driven by helical gears.

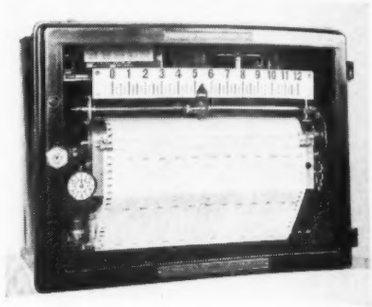
These engines have L-head cylinders and the valves have 30-deg. seats. The exhaust valve has a clear diameter of 1⅛ in., and the intake valve 1¼ inches. The crankshaft in the "NX" series is counterbalanced to compensate for the full amount of the rotating mass, plus 45 percent of the reciprocating mass, producing exceptionally smooth 2-cylinder operation.

Provision is made for the usual accessories, including generator, starter, flange-mounted magneto, battery-type distributor, mechanical governor, fuel pump, fan drive, and 1-in. carburetor.

Many of the parts used in the "NX" series 2-cylinder engines are interchangeable with the same parts in the "IX" series 4-cylinder engines.

Brown Multiple Recording Potentiometer Pyrometer

BROWN Instrument Company's engineers have incorporated many new features in the Brown multi-color numeral printing potentiometer pyrometers that can be briefly summed up as simplicity of design, ruggedness, and durability. This instrument insures



precision measurement of temperatures and provides a legible record in both multi-color and numerals, the makers state. With this method of recording several temperatures on one chart, when temperature changes overlap no special skill is required to decipher the easily-read multi-color numerals on the Brown multiple recording potentiometer pyrometer chart, it is pointed out.

Only one symbol, the plus sign, is used and the numeral identifies the thermocouple from which the temperature record is being made. The plus sign (an exclusive feature) of the Brown multiple recording potentiometer pyrometer is no mere arbitrary, ornamental dot, but has a definite, practical significance in multiple temperature recording. The vertical line of the plus sign identifies the temperature and the horizontal line the time coordinate. The intersection of the two lines locates the exact point on the time-temperature record.

The wide 12-in. chart and the distinct imprint of the number print wheel makes it possible to record continuously from two to six temperatures from as many different thermocouples, the manufacturers say.

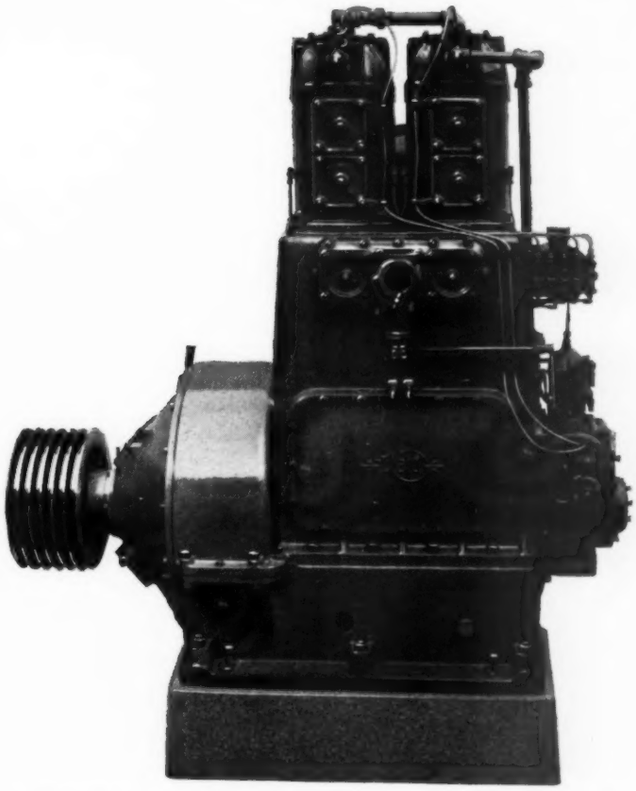
The Brown multiple recording potentiometer pyrometer has all the inherent features of the standard Brown potentiometer pyrometer, including the 40-in. slide wire, enclosed galvanometer, rugged drive mechanism, synchronous motor, etc.

Catalog No. 1102 gives full details. A copy will be sent upon request. Address: The Brown Instrument Company, Wayne and Roberts Avenues, Philadelphia, Pennsylvania.

Reid Vertical Gas Engine

THE Reid Type V-2, 7½-in. by 9-in., twin-cylinder vertical gas engine is a new addition to the Reid line of pumping engines, manufactured by the Joseph Reid Gas Engine Company of Oil City, Pennsylvania. This engine is of the two-cycle, crosshead type, and includes in its design many features of construction that have been thoroughly tested in the Reid horizontal-type engines. It is of rugged construction, with particular attention being given to the accessibility of all working parts, at the same time keeping the unit entirely enclosed and dustproof.

Features of the design include: shell-type, steel-backed, babbitt-lined, main bearings; three-bearing crankshaft; heavy flywheel to eliminate vibration; patented crosshead and piston rod connection; nickel-content piston and combustion head; location of controls in one main assembly; built-in circulating water pump; and ample provision for lubrication.



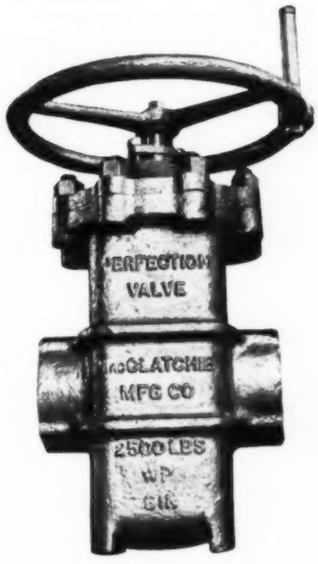
The power take-off may include a twin disc clutch and flat-belt or V-belt pulley, or may be supplied with solid- or flexible-type coupling for direct connection. Complete engineering data and power and fuel consumption charts are given in Bulletin No. 80, copies of which may be obtained upon request.

Ridgoil Has Antiseptic Quality

PREVENTING the risk of infection, a new antiseptic quality is present in Ridgoil, it was recently announced by The Ridge Tool Company, Elyria, Ohio, makers of this sulphur-base cutting oil. Besides this antiseptic quality, hundreds of experiments with many kinds of oils have shown Ridgoil to be highly satisfactory for cutting smooth clean threads on iron, steel, or brass pipe, the manufacturers add. It penetrates quickly, cools and lubricates. It will not congeal above 20 deg. fahrenheit.

MacClatchie Perfection Gate Valve

THE MacClatchie Perfection Gate Valve is a new type of valve having performance features that give long fool-proof operation at a minimum of maintenance cost, according to the manufacturers, the MacClatchie Manufacturing Company, Compton, California. The valve is constructed on a new principle, the sliding member being split vertically to form two parts. In opening and closing the valve there is ample clearance between sliding member and body to allow free, frictionless operation. At the bottom and top of the stroke, however, built-in pawls cause the two valve segments to expand against the walls of the valve, sealing off the clearance space so that dirt, sediment, and scale cannot enter. The operation is automatic and positive, according to the manufacturers.



When the MacClatchie Perfection Gate Valve is open there is a full-sized opening through the valve. This feature means not only unrestricted fluid flow, but also longer valve life due to the elimination of "jetting action," it is pointed out.

The Perfection Valve is a self-lubricated valve, containing space for sufficient grease to lubricate it throughout its life. This feature assures friction-free operation and complete protection of the valve mechanism both from wear and corrosion.

This new valve is a regular "sandhog," and can handle a considerable volume of sand-laden fluid at a nominal maintenance cost, it is claimed. Sand cannot work into the bottom sump, nor into the threads in the top, to "freeze" the valve and decrease operating efficiency, it is stated. Packing has been placed scientifically to give proper sealing, and to avoid leakage when the valve is opened or shut. Another sand-resisting feature is that in the open position there is no fluid restriction. This means that the fluid does not increase in velocity as it goes through the valve, and therefore fluid abrasion is greatly reduced.

The MacClatchie Perfection Valve is made in 750-, 1500-, and 3000-lb. pressure models in a wide variety of sizes. Write for complete information.

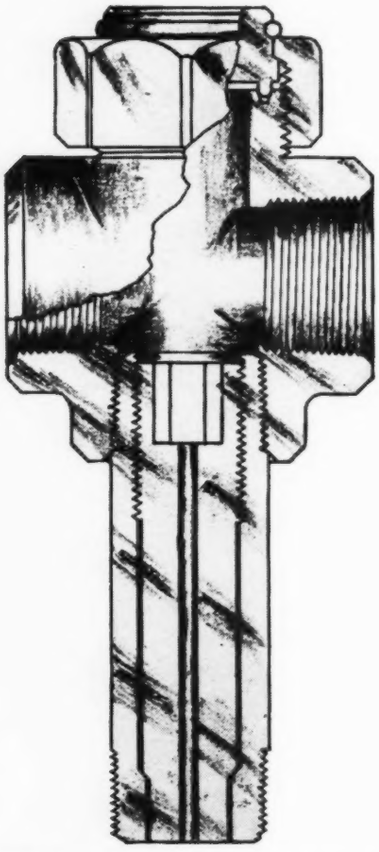
Grizzly Rotary Brake Blocks Readily Available

A PORTION of the large stock of Grizzly Rotary Brake Blocks maintained in their large factory warehouse by the manufacturer, E. M. Smith Company, Los Angeles, California, is shown in the accompanying picture.

These brake blocks are now available to oil companies in connection with the Grizzly Rotary Brake Block Band Exchange, recently inaugurated by the manufacturer. Under this plan, Grizzly Brake Blocks are installed at the factory on new bands for any type of rotary machine, at no extra cost, and delivered to the rig ready for use. It assures getting genuine Grizzly blocks of the correct size and type for each rotary, perfectly installed on the bands, the manufacturers state.

Complete stocks for all types of rotaries are carried by leading supply companies, as well as at the E. M. Smith Company warehouse in Houston, Texas, and Oklahoma City, Oklahoma.

O-C-T Type "FC-100" Flow Cross



THE O-C-T flow fitting, shown in the accompanying illustration, is available in either cross or tee type, and is designed for use with any standard type choke that permits replacement of the bean through the flow fitting.

A special cap with swivel nut replaces the conventional bull plug. A coarse, straight thread connection between the fitting and swivel nut prevents galling of the threads as sometimes occurs if the bean is changed constantly, the manufacturers state.

A ring, machined integrally with the cap nut, effects a seal in a groove provided on the flow fitting.

Lincoln Electrode Holder

A NEW arc-welding electrode holder, the feature of which is its remarkably light weight for the capacity, has been announced by The Lincoln Electric Company, Cleveland, Ohio.

The new holder (see illustration), designated "Type ST," weighs only 14

ounces and has a current capacity of 250 amp. continuous, equaling that of many type holders weighing 25 ounces or more, the makers state. The light weight, obtained without any sacrifice of capacity, is attributed to use of formed steel parts, electrically welded.

The new holder also has a number of other advanced features, most important of which is probably the extremely simple type of connection that assures positive contact and eliminates loose connections, a more or less common cause of overheating in holders.

To assure permanence of connections, all contacts are electrically welded, the manufacturers point out. Connection to cable is provided by a special, easily operated clamp that locks the cable to the electrode holder. The clamp can be tightened or loosened without tools, by inserting a welding electrode through a hole in the square head of the clamp cap screw and applying leverage. (Patent applied for.) When tightened, this clamp maintains positive contact with the flat-braided flexible copper strip that carries current to the jaws. The result is a complete copper low-resistant circuit direct from the welding machine through the holder to the electrode.

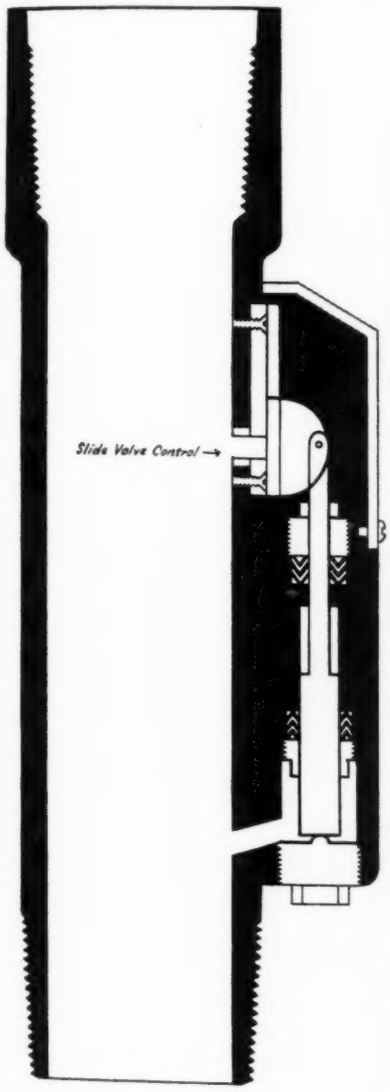
Other important features are: reduced overall width; more facile welding in corners and other confined places; rounded rather than square corners at important points to lessen the likelihood of contacting the holder and causing arcing; use of heavier copper jaws to assure maximum conductivity and prevent sticking of the electrode to the holder; grooving of the jaws for vertical and overhead as well as flat welding; a hollow fibre handle, proportioned to fit the user's hand and affording a positive grip fully insulated thumb lever and non-groundable sturdy spring.

Goodrich Type 72 Compressed Asbestos Sheet Packing

THE B. F. Goodrich Company, Akron, Ohio, has announced an addition to their line of compressed asbestos sheet packing that is known as Type 72. Black in color with graphite mixed throughout, this new packing is recommended for temperatures above 212 deg. fahr. when gaskets are in contact with oil or solvent vapors.

Foley Flow Valve

THE Foley compounded outside-type flow valve, manufactured by Jon R. Long, West Rio Grande Avenue and Frisco Tracks, Fort Worth, Texas, is actuated by differential pressures applied to a compounded piston. The gas pressure is applied to the small end of

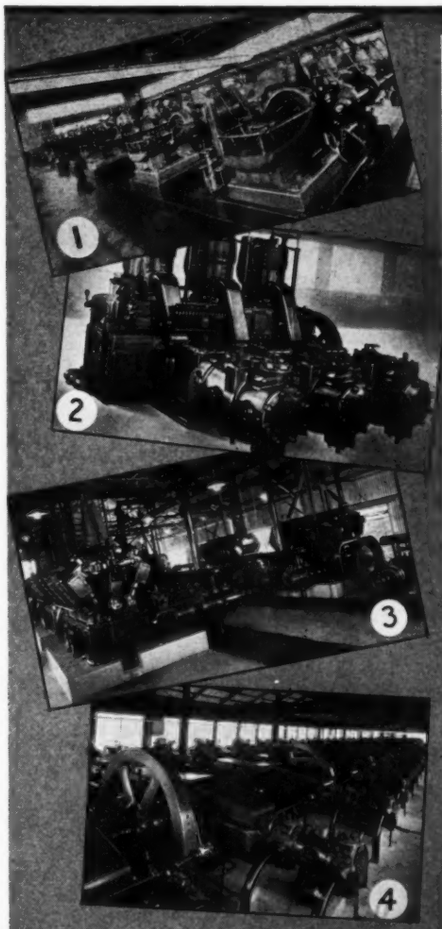


the piston and the fluid pressure in the tubing is applied to the large end of the compounded piston. The piston in turn operates a slide valve that controls the input gas. The slide valve is well known for its positive shut-off, having been used for years in steam chests of pumps and engines, the manufacturers point out.

The packing is of the "U" type for handling high pressures. All working parts of the valve are made from Ka-Alloy, a corrosion-resisting alloy having a high nickel content. The valve body is made from SAE 3140 steel casting.

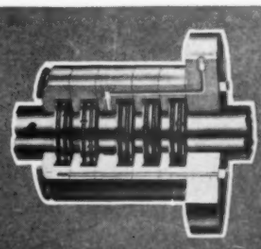
The valve is closed when it is run into the well and remains closed as the gas pressure builds up on the small end of the compounded piston. As the tubing fills with fluid, pressure is built up on the large end of the piston. When the fluid pressure times the cross-section area of the large end of the piston exceeds the gas pressure times the area of the small piston, the piston will move the slide valve and uncover the gas port. When the fluid has been forced from the tubing, relieving the tubing pressure, the gas pressure causes the valve to close until fluid again accumulates in the tubing. Gas cannot pass through the valve unless there is fluid in the tubing to actuate the piston and uncover the gas port.

Seal your reciprocating piston rods
the way so many engine and compressor operators do... with
COOK'S METALLIC PACKINGS



Wherever you may look throughout the oil and gas fields you will find COOK'S Metallic Packings predominating on the power and compressor rods of gas pumping and gasoline extraction engines. Noteworthy applications are represented by the engines, shown in the accompanying illustrations, that come factory equipped with COOK'S modern Packings.

Make sure you get the genuine COOK'S Packings when buying new equipment by specifying their use. For existing equipment communicate with us direct, or our nearest branch office.



1-COOPER-BESSEMER CORP.
2-CLARK BROTHERS COMPANY
3-INGERSOLL-RAND COMPANY
4-WORTHINGTON P&M CORP.

C. LEE COOK
MANUFACTURING CO.
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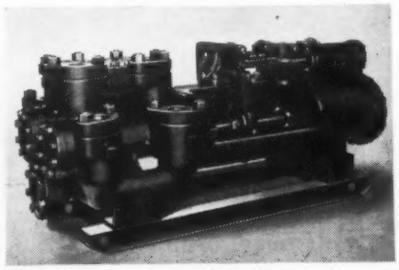
BALTIMORE • SAN FRANCISCO

F-M Duplex Steam Pump

A NEW duplex steam pump having eight-cover side-pot type fluid end and improved piston valve steam end has been announced by Fairbanks, Morse and Company. This new Fig. 6285 steam pump offers an economical means of handling oil, water or other free-flowing liquids at high pressures and in large quantities, the manufacturers state. This pump was developed particularly for industrial and oil-field boiler-feed service, but is well suited to many applications. Sizes are available for capacities up to 148 gal. per min. and fluid-end pressures up to 1000 lb. per sq. inch.

The balanced, piston-type steam valves assure efficient operation even



with high steam pressures and with super-heated steam, it is pointed out. Valve openings close completely, without loss of pressure, under all conditions of temperature and pressure, it is stated.

The eight-cover side-pot fluid end permits easy servicing. Each suction and discharge valve is placed in its own valve pot and is easily accessible by the removal of a single valve pot cover. Large and direct fluid-end passageways offer low resistance to flow.

The steam and fluid ends are each effectively sealed by an ample supply of packing in an extra-deep stuffing box fitted with a removable bolted gland. The cradle between the steam and fluid ends is long enough to permit access to both stuffing boxes. No part of the piston rod enters both stuffing boxes.

Bulletin 6185, available from Fairbanks, Morse and Company, 900 South Wabash Avenue, Chicago, Illinois, describes fully the construction features of the new Fig. 6285 duplex steam pump.

This same type of eight-cover side-pot fluid end is available also in the F-M Fig. 6185 duplex power pumps for motor, belt, or engine drive. These have enclosed self-oiling power ends with herringbone gears and large roller bearings.

Worthington Rotary Pumps Designed for Viscous Chemicals

A complete line of specially-designed rotary pumps is now built by the Worthington Pump and Machinery Corporation of Harrison, New Jersey, for viscous chemicals. They are ruggedly constructed to transfer such substances as: sulphonated oils, fatty

acids, tallows, tars, asphalts, glues, gelatins, glycerine, petrolatum, residuum, hot bottoms, mineral oils, greases, animal and vegetable oils, molasses, sugar syrups, glucose, cellulose acetates and nitrates, viscose, rayons, cellophane, and various film dopes.

These pumps are available in iron, bronze, Monel, nickel, Everdur, stainless steel, aluminum, etc., for capacities up to 700 gal. per min., pressures up to 150 lb. per sq. in., and viscosities up to 500,000 SSU or 110,000 centipoises.

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Fig. 747A Fig. 718

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E. J. McKee Passes Away

E. J. McKee, general superintendent of drilling and production for the Barnett Petroleum Corporation, Dallas, Texas, died December 31 while undergoing an operation.

Born at Petrolia, Pennsylvania, 55 years ago, McKee joined the staff of the National Transit Company immediately upon graduating from University of Pittsburgh. Later he came to the

E. J. McKEE

Mid-Continent as an engineer with The Texas Company, leaving that firm to join the staff of the Cosden Oil Corporation in the same capacity.

From 1920 to 1922 McKee operated as an independent, at which time he accepted a professorship at the Missouri School of Mines, Rolla, Missouri, and established a petroleum engineering school at that institution. In 1925 he resigned to become chief petroleum engineer of the Phillips Petroleum Company, making his headquarters at Bartlesville, Oklahoma. He remained there until 1930, and from that time until 1937 was first with the Wirt Franklin Petroleum Corporation, then the Anderson-Prichard Oil Corporation, being stationed at Oklahoma City. He joined the staff of the Barnett Petroleum Corporation in February, 1937.

N. G. A. A. Convention, May 11-13

The 1938 convention of the Natural Gasoline Association of America will be held at the Hotel Tulsa, Tulsa, Oklahoma, May 11-13, according to a recent announcement by William F. Lowe, secretary of the association.

Plans for an unusually interesting meeting are already being formed under the direction of a convention committee recently appointed by J. A. LaFortune, Warren Petroleum Corporation, president of the N.G.A.A. Chairman of this important committee is J. W. Vaiden, Skelly Oil Company, Tulsa. Other members are: R. C. Alden, Phillips Petroleum Company, Bartlesville, Oklahoma; W. A. Baden, Warren Petroleum Corporation, Tulsa; R. E. Beckley, Standard Oil Company of California, San Francisco, California; T. R. Goebel, Shell Petroleum Corporation, Tulsa; J. R. Jarvis, Lone Star Gasoline Company, Dallas, Texas; and P. M. Raigorodsky, Glen Rose Gasoline Company, Tulsa.

R. L. Howes in Charge New A. O. Smith Office

A. O. Smith Corporation, Milwaukee, Wisconsin, announce the opening of a district office in Pittsburgh in the Gulf Building at 439 Seventh Avenue. This office is in charge of R. L. Howes.

Howes has had broad experience as a mechanical engineer in petroleum and allied industries. During the last three years Howes has been eastern manager of Diesel engine sales for the Worthington Pump and Machinery Corporation.

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W. P. R. A. Annual Meeting at Hot Springs, April 25, 26, 27

Mid-Continent refiners will meet in Hot Springs, Arkansas, April 25, 26, and 27 to discuss their technical and economic problems at the 26th annual meeting of the Western Petroleum Refiners Association, A. V. Bourque, secretary-treasurer of the association has announced.

The technical phase of the program, being arranged by Emby Kaye, chairman of the manufacturing committee, will include several of the recently-developed refining and treating processes and a discussion of the results of the vapor lock road tests conducted last summer by the refiners association and the Natural Gasoline Association.

The road tests revealed inefficiencies in the fuel and carburetion systems of many American motor cars that caused wastage of gasoline, loss of power, and failure to utilize the full value of the refiners' gasoline production.

The technical sessions of the meeting will be held on Monday afternoon and Tuesday morning; the general sessions, devoted to economic and legal problems will be held Tuesday afternoon and Wednesday morning. A dinner dance to celebrate the 26th anniversary of the association will be held Tuesday night in the ball room of the Arlington hotel where all sessions are to be held.

Martin-Decker Appoints Mid-Continent Representative

JACK CLEMENS

The Martin-Decker Corporation, Long Beach, California, has appointed Jack Clemens their new Mid-Continent representative. Although new to the Mid-Continent area, Jack has been with the Martin-Decker organization for almost ten years, and is thoroughly familiar with the many scientific instruments that comprise the Martin-Decker line. He will work in conjunction with the Reed Roller Bit Company, who handle the Martin-Decker line in the Mid-Continent, making his headquarters at Odessa, Texas. From there he will cover the West Texas, Southwest Texas, and New Mexico territories.

Company Dissolved

The Oklahoma Contracting Company, Dallas, Texas, pipe line contractors, has been dissolved and T. R. Jones and W. G. Hanrahan are now operating separately. Jones is operating as T. R. Jones, Inc., having offices at 1513 Magnolia Building, Dallas; and Hanrahan is operating as W. G. "Bill" Hanrahan, Pipe Line Contractor, and his offices are at 1511 Magnolia Building, Dallas.

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C. L. Lockett, Jr., Export Manager Oil Well Supply

On January 1, Charles L. Lockett, jr., became manager of the Export Division of Oil Well Supply Company, succeeding George E. Niver, who joined National Tube Company in Pittsburgh, Pennsylvania. Lockett will maintain his office at "Oilwell's" export headquarters, 30 Rockefeller Plaza, New York City.

C. L. LOCKETT, JR.

Lockett is a graduate engineer of Ohio State University. Following his graduation he was employed as an engineer by Ohio Fuel Supply Company and later as southwestern sales manager for International Derrick and Equipment Company. He joined "Oilwell" as sales engineer in 1934.

In 1936, Lockett was appointed manager of export sales, in which capacity he continued until his recent promotion to manager of the Export Division. He has traveled extensively and is well-known in many oil fields, both domestic and foreign.

B. E. Sibley Elected Vice-President S.A.E.

B. E. Sibley, chief technologist for Continental Oil Company, has been elected a vice - president of the Society of Automotive Engineers. The election was announced after tellers had canvassed more than 7000 mail ballots from the society's international membership.

B. E. SIBLEY

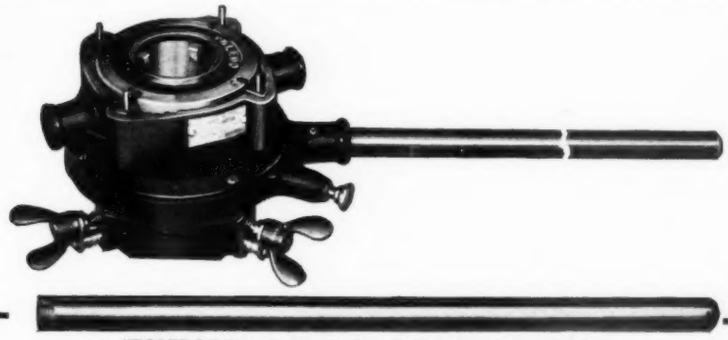
Sibley, who has been active in the affairs of the society for a number of years, has served on its techincal research committees dealing with aircraft, bearings, and interior engine design and lubrication. He is also a member of the American Society of Mechanical Engineers, and for many years was chairman of its Rocky Mountain Section.

N. R. Birge Elected Vice-President General Electric

Nathan R. Birge, assistant to the president of the General Electric Company since 1927, has been elected a vice - president of the company, it has been announced by President Gerard Swope. Birge will be situated in Schenectady, where he has carried on his duties in the past.

NATHAN R. BIRGE

Mr. Birge entered the employ of General Electric on August 6, 1900, following his graduation from Worcester Polytechnic Institute with the degree of B.S. in electrical engineering. In 1902 he was transferred to the former supply department of the company, later becoming manager of the street lighting section. He was named assistant manager of the supply department in 1923, and in November of that year was transferred to the executive department. He was made assistant to the president in July, 1927.



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Record Number of Exhibitors Signed for Petroleum Show

ALL records for total number of exhibitors at former International Petroleum Expositions will be surpassed by the 1938 oil show as 476 applications for space already have been received, as compared to the total of 397 exhibitors at the 1936 show.

The applicants for the 1938 Exposition, to be held May 14 to 21 at Tulsa, Oklahoma, have reserved 60 percent more space than was sold for the entire 1936 show. To provide for this unprecedented demand for exhibit space the exposition officials have started construction of three new buildings and have added five acres to the grounds.

Wm. B. Way, general manager of the show, said that all firms making application for space will be taken care of regardless of how much space already has been sold.

Among the firms that already have been issued contracts for the 1938 Exposition are:

Aero Exploration Co., Tulsa; Ahlberg Bearing Co., Chicago; The Aire-Tool Manufacturing Co., Springfield, Ohio; Air-Maze Corp., Cleveland; Air Reduction Sales Co., New York; Allis-Chalmers Manufacturing Co., Milwaukee; Allsteel Products Manufacturing Co., Wichita; American Automatic Electric Sales Co., Chicago; American Can Co., Chicago.

American Chain and Cable Co., Bridgeport, Conn.; American Iron and Machine Works Co., Oklahoma City; American La-France and Foamite Industries, Elmira, N. Y.; American Optical Co., Kansas City; American Roller Bearing Co., Pittsburgh; American Rolling Mills Co., Middletown, Ohio; American Sand-Banum Corp., Inc., New York; Ames Baldwin Wyoming Co., Parkersburg, W. Va.; Appleton Electric Co., Chicago; Armstrong Blum Manufacturing Co., Chicago; Armstrong Machine Works, Three Rivers, Mich.; Asbestos Manufacturing Co., Huntington, Ind.; Athey Truss Wheel Co., Chicago.

Atlas Supply Co., Muskogee, Okla.; Baash-Ross Tool Co., Los Angeles; Bailey Meter Co., Cleveland; Baker Oil Tools, Inc., Huntington Park, Calif.; Baldwin-Duckworth Chain Corp., Springfield, Mass.; Baroid Sales Co., Los Angeles; Bastian Blessing Co., Chicago; Beaver Pipe Tools, Inc., Warren, Ohio; Beck Engineering Combustion Co., St. Louis; Benjamin Electric Co., Des Plaines, Ill.; Bethlehem Supply Corp., Tulsa.

Black, Sivalls and Bryson, Oklahoma City; Bovaird Supply Co., Tulsa; Bridgeport Brass Co., Bridgeport, Conn.; Bridgeport Machine Co., Wichita; The Bristol Co., Waterbury, Conn.; Ralph N. Brodie Co., Oakland; Brown Instrument Co., Philadelphia; Buckeye Traction Ditcher Co., Findlay, Ohio; Bucyrus-Erie Co., S. Milwaukee; Buda Co., Harvey, Ill.; Byron Jackson Co., Los Angeles; Caterpillar Tractor Co., Peoria.

Central Forging Co., Catawissa, Pa.; Chain Belt Co., Milwaukee; Chaplin-Fulton Manufacturing Co., Pittsburgh; Chase Brass and Copper Co., St. Louis; General Motors Sales Corp., Detroit; Coffing Hoist Co., Danville, Ill.; C. Lee Cook Manufacturing Co., New York; Chicago Bridge and Iron Works, Chicago; Chiksan Oil Tools Co., Fullerton, Calif.; Clark Brothers Co., Olean, N. Y.; Clark Elec. Supply Co., Tulsa; Cleveland Trencher Co., Cleveland.

Compressed Industrial Gases, Inc., Tulsa; Continental Supply Co., Dallas; Cooper-Bessemer Corp., Mt. Vernon, Ohio; Crane Co., Chicago; Crane Packing Co., Chicago; Crouse-Hinds Co., Syracuse; Darling Valve and Manufacturing Co., Williamsport, Pa.; The Dayton Rubber Manufacturing Co., Dayton; Dearborn Chemical Co., Chicago; Deep Rock Oil Corp., Tulsa; The Dehydro Co., Tulsa; Diamond Chain and Manufacturing Co., Indianapolis.

Dodge Manufacturing Co., Mishawaka, Ind.; Dowell, Inc., Midland, Mich.; E. I. Dupont de Nemours and Co., Wilmington, Del.; Dura-metallic Corp., Kalamazoo, Mich.; Eagle-Picher Sales Co., Cincinnati; Eastman Oil Well Survey Co., Dallas; Elliott Co., Jeanette, Pa.; Emerol Manufacturing Co., New York; The Engineering Co., Tulsa; Ensign Carburetor Co., Ltd., Huntington Park; George E. Failing Supply Co., Enid, Okla.

Fisher Governor Co., Marshalltown, Iowa; Four Wheel Drive Auto Co., Clintonville, Wis.; Foxboro Co., Foxboro, Mass.; The France Packing Co., Philadelphia; Franks Manufacturing Co., Tulsa; Frick Co., Waynesboro, Pa.; Frick-Reid Supply Co., Tulsa; Green Head Bit and Supply Co., Oklahoma City; Garlock Packing Co., Palmyra, N. Y.; Gaso Pump and Burner Manufacturing Co., Tulsa; Gates Hardware Co., Tulsa; Gatke Corp., Chicago; Gearench Manufacturing Co., Houston.

General Paint Corp., Tulsa; Geuder, Paeschke and Frey Co., Milwaukee; Grant Oil Tool Co., Los Angeles; The Guiberson Corp., Dallas; Gustin-Bacon Manufacturing Co., Kansas City.

Halliburton Oil Well Cementing Co., Duncan, Okla.; Hanlon-Waters, Inc., Tulsa; Happy Belting Co., Tulsa; Harnischfeger Corp., Milwaukee; Hercules Tool Co., Tulsa; Hills-McCanna Co., Chicago; Hinderliter Tool Co., Tulsa; The C. N. Hough Manufacturing Co., Franklin, Pa.; Hughes Tool Co., Houston; Hyatt Bearings Division, General Motors Corp., Harrison, N. J.; Ingersoll-Rand Co., Phillipsburg, N. J.; International Derrick and Equipment Co., Columbus; International Harvester Co., Chicago; International Nickel Co., N. Y.; Iverson Tool Co., Tulsa; Jarecki Manufacturing Co., Tulsa.

Johns-Manville Co., New York; The Johnston-Jennings Co., Cleveland; The S. M. Jones Co., Toledo; Jones and Laughlin Steel Corp., Pittsburgh; Joyce-Cridland Co., Dayton, Ohio; Keasby and Mattison Co., Ambler, Pa.; Kerotest Manufacturing Co., Pittsburgh; Keuffel and Esser Co., St. Louis; Walter Kiddie and Co., New York; M. M. Kinley Co., Houston; Koppers Co., Baltimore; Landis Machine Co., Waynesboro, Pa.; The Lane-Wells Co., Los Angeles; Larkin Packer Co., St. Louis; Leeds and Northrup Co., Philadelphia.

Leland Equipment Co., Tulsa; A. Leschen and Sons Rope Co., St. Louis; Lincoln Electric Co., Cleveland; Line Scale Co., Inc., Oklahoma City; Link-Belt Co., Chicago; The Louis Allis Co., Milwaukee; Lucey Products Corp., Tulsa; Lufkin Foundry and Machine Co., Lufkin, Tex.; The Lunkenheimer Co., Cincinnati; Lycoming Manufacturing Co., Williamsport, Pa.; MacClatchie Manufacturing Co., Compton, Calif.; McCord Radiator and Manufacturing Co., Detroit.

Macwhyte Co., Kenosha, Wis.; Maloney Tank Co., Tulsa; Manzel Bros. Co., Buffalo; Marmon-Herrington Co., Inc., Indianapolis; Jas. P. Marsh Corp., Chicago; Martin-Decker Corp., Long Beach, Calif.; Mason-Neilan Regulator Co., Boston; C. A. Mathey Machine Co., Tulsa; Mid-Continent Petroleum Corp., Tulsa; Mid-Continent Supply Co., Ft. Worth.

Mine Safety Appliances Co., Pittsburgh; Mission Manufacturing Co., Houston; Lee C. Mcore and Co., Inc., Pittsburgh; Moorlane Co., Tulsa; Morrison Brothers, Dubuque, Iowa; Motor Improvements, Inc., Newark; Murray Tool and Supply Co., Tulsa; Muskogee Iron Works, Muskogee, Okla.; National Carbide Sales Corp., New York; National Lead Co., St. Louis; National Radiator Co., Johnstown, Pa.; National Supply Co. of Delaware, Toledo; National Tank Co., Tulsa.

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Templeton, Kenly & Co., Ltd., Chicago; The Texas Co., Houston; Texas Steel Co., Ft. Worth; Thompson Pump Co., Okmulgee; The Timken Roller Bearing Co., Canton, Ohio; The Timken Roller Bearing Co., Steel and Tube Division, Canton; The Tokheim Co., Tulsa; Trackson Co., Milwaukee; Triangle Blue Print Co., Tulsa; Trimont Manufacturing Co., Roxbury, Mass.; Tulsa Rig and Reel Co., Tulsa; Twin Disc Clutch Co., Racine, Wis.; Tyson Roller Bearing Corp., Massillon, Ohio; Una-Weld Manufacturing Co. of Texas, Houston; Union Carbide and Carbon Corp., New York; Union Wire Rope Corp., Kansas City.

United American Bosch Corp., Springfield, Mass; Universal Engineering Co., Los Angeles; U. S. Electric Tool Co., Cincinnati; United States Steel Corp., Pittsburgh; Vapor Recovery Systems Co., Compton, Calif.; Viking Pump Co., Cedar Falls, Iowa; Vinson Supply Co., Tulsa; Vortex Manufacturing Co., Claremont, Calif; W-K-M Co., Houston; Wackman Welded Ware Co., Tulsa.

Wall Rope Works, Inc., Tulsa; Walworth Co., Inc., New York; Waukesha Motor Co., Waukesha, Wis.; Webster Engineering Co., Tulsa; Well Machinery and Co., Ft. Worth; Westinghouse Electric Manufacturing Co., East Pittsburgh; Western Iron and Foundry Co., Wichita; The White Motor Co., Kansas City; Wico Electric Co., Springfield, Mass.; Wickwire Spencer Steel Co., New York; Willard Storage Battery Co., Cleveland; J. H. Williams and Co., New York; Wilson Welder and Metals Co., New York.

Wilson and Bennett Manufacturing Co., Chicago; Wilson Manufacturing Co., Wichita Falls; Worthington Pump and Machinery Corp., Harrison, N. J.; Yale and Towne Manufacturing Co., Philadelphia; Young Engine Corp., Canton, Ohio; John Zink Co., Tulsa.

Firms that have requested space but have not yet had it assigned to them pending completion of new building plans, are:

Acheson Colloids Corp., Port Huron, Mich.; Acme Foundry and Machine Co., Coffeyville, Kans.; Aeco Packing Products Co., Chicago; Aganox Co., New Orleans; Air Cooled Motor Corp., New York; Alten's Foundry and Machine Works, Lancaster, Ohio; American Askania Corp., Houston; Ampco Metal, Inc., Milwaukee; Anchor Burner Co., Oklahoma City; Anchor Packing Co., Tulsa; Axelson Manufacturing Co., Los Angeles.

Barber Greene Co., Aurora, Ill.; Dan M. Bell, Dallas; Black and Decker Manufacturing Co., Townson, Md.; Braden Winch Co., Tulsa; Buffalo Gasoline Motor Co., Tulsa; Bunting Brass and Bronze Co., Toledo; Burke-Greis Oil Corp., Tulsa; Butler Manufacturing Co., Kansas City; Buyers Machine Co., Ravenna, Ohio.

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Wallace Davis, Houston; De Laval Separator Co., Chicago; De Walt Products Corp., Lancaster, Pa.; Diamond T Motor Car Corp., Chicago; Dickey Clay Manufacturing Co., Kansas City; Dillon Co., Tulsa; Dow Chemical Co., Midland, Mich.; S. R. Dresser Manufacturing Co., Bradford, Pa.; Duff-Norton Manufacturing Co., Pittsburgh.

Edward Valve and Manufacturing Co., Inc., East Chicago, Ind.; Electric Hose and Rubber Co., Chicago; Elliott Manufacturing Co., Los Angeles; Emmons Supply Co., Taft, Calif.; Emsco Derrick and Equipment Co., Los Angeles; Encyclopaedia Britannica, Kansas City; Ericson Manufacturing Co., Cleveland, Ohio; Exner-Dodge Packer Co., Coffeyville, Kan.

Fafnir Bearings, Inc., New Britain, Conn.; Fairbanks, Morse and Co., Chicago; Farrel-Birmingham Co., Buffalo; Fish-Schurman Corp., New York; Fluid Packed Pump Co., Oklahoma City; Foote Bros. Gear and Machine Co., Chicago; Franks Radiator Service Co., Tulsa.

Gas Lift Corp., Dallas; Gates Rubber Co., Denver; General Electric Co., Schenectady, N. Y.; General Motors Corp., Detroit; George Valve Co., Saegertown, Pa.; Gilmer Co., Tacony, Pa.; Gray Tool Co., Houston.

Haveg Corp., Chicago; Hercules Powder Co., Wilmington, Del.; Holder-Jewell, Duncan, Okla.; Horn Co. of Texas, Houston; Hutchison Engineering Works, Chicago; Hydril Co. of Texas, Houston.

Ilg Electric Ventilating Co., Chicago; International Supply Co., Tulsa; Jackson, W. V. C., Tulsa; Jacobs Wind Electric Co., Minneapolis; Jeffrey Manufacturing Co., Columbus, Ohio; Johnson Bronze Co., New Castle, Pa.

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Union Chain and Manufacturing Co., Sandusky, Ohio; Union Gas System, Inc., Independence, Kan.; Union Metal Manufacturing Co., Canton, Ohio; Unit Rig and Equipment Co., Tulsa; United Air Cleaner Co., Chicago; United Supply and Manufacturing Co., Tulsa; Viele Valve Corp., Elmira, N. Y.; Visco Products Co., Houston; Vulcan Machine and Manufacturing Co., Ltd., Oakland; Walker-Turner Co., Plainfield, N. J.; Wallace Co., George N., New York; Welding Engineer, Chicago; Westcott and Greis, Inc., Tulsa; Western Engine Corp., Wheatley Bros., Pump and Valve Manufacturers, Tulsa; Wheeling Corrugating Co., Wheeling; Whitney Chain and Manufacturing Co., Hartford; Williamsport Wire Rope Co., Chicago; Wolverine Tube Co., Detroit; Wood Shovel and Tool Co., Piqua, Ohio.

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Rocky Mountain Crude Oils Analyzed by the Bureau of Mines

TWELVE crude oils from ten new fields and new producing horizons in oil fields in the Rocky Mountain region have been analyzed by the Bureau of Mines, United States Department of the Interior. The discovery of these fields is the result of intensive search during the last few years to augment present supplies of light oil. The analyses were made by the Bureau of Mines Hempel method, and production data and a brief history of each field are given in a report just published. Analyses of samples from Cut Bank and Pondera fields in Montana, Hiawatha and Powder Wash fields in Colorado, and Lance Creek (Dakota, Upper Sundance, and basal Sundance crudes), Medicine Bow, Quealy, Rock Creek (Sundance crude), Waugh Dome, and Wertz Dome fields, all in Wyoming, are included.

The Cut Bank field in Glacier County and the Pondera field in Pondera County, northwestern Montana, both produce intermediate base, wax-bearing crude oils of 37.0-deg. and 31.9-deg. A.P.I. gravity, respectively. The Pondera oil is similar to that of Cut Bank in basic characteristics; however, it contains less gasoline and naphtha and more sulphur and asphalt than the Cut Bank crude oil.

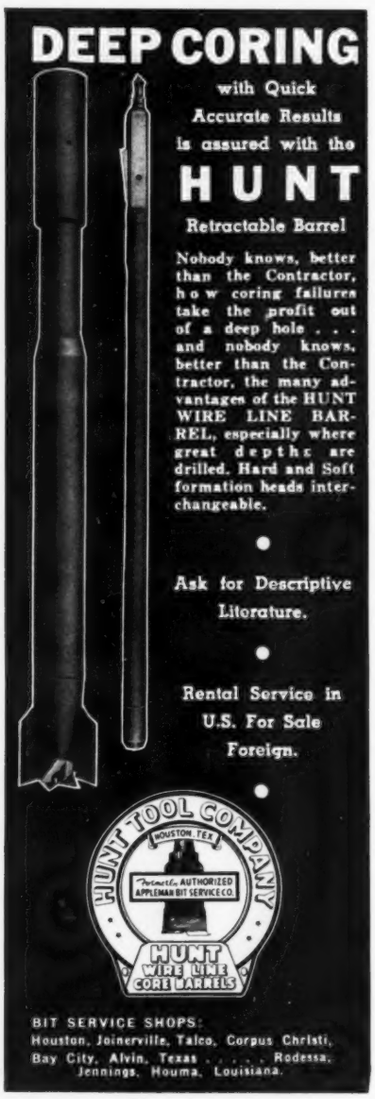
The Hiawatha and Powder Wash fields are in the same general area in Moffat County, northwestern Colorado. The Hiawatha field extends north into Sweetwater County, Wyoming. Although both fields are principally producers of gas, a few of the wells produce a small amount of crude oil with the gas. Both fields produce oil from the Wasatch formation of the Tertiary; both crudes are of 35.0-deg. A.P.I. gravity, intermediate-paraffin base and wax bearing, and are similar in other characteristics. Although these two oils are classified as intermediate-parraffin base by the Bureau of Mines method of interpretation, their light fractions are naphthenic in character. The distillates boiling below 200 deg. cent. from the Powder Wash crude and that boiling below 250 deg. cent. from the Hiawatha crude are considerably heavier (lower A.P.I. gravity) than the corresponding distillates from the average intermediate base crude oil.

The crude oils produced from the Sundance sands in the Medicine Bow and Rock Creek fields, Carbon County, and the Lance Creek field, Niobrara County, Wyoming, are similar in basic characteristics although they differ considerably in gravity and gasoline and naphtha content. Their A.P.I. gravities are: Medicine Bow, 63.4 deg., Rock Creek, 36.0 deg., Lance Creek, upper Sundance, 42.8 deg., and Lance Creek, basal Sundance, 49.4 degrees. The bases of these crudes are paraffin, paraffin-intermediate, or intermediate with properties falling near the dividing line between the classes.

The crude oil produced from the Dakota sand in the Lance Creek field, which is representative of the production of the field prior to the discovery of oil in the Sundance sands, is of intermediate-paraffin base, wax bearing, and has an A.P.I. gravity of 37.8 degrees. Another Dakota sand field, the Quealy Dome, Albany County, Wyoming, produces an intermediate base, wax-bearing oil of 33.2-deg. A.P.I. gravity.

The crude oils produced from the Waugh Dome field, Hot Springs County, and the Wertz Dome field, Sweetwater County, Wyoming, are intermediate base and wax bearing and because of their high sulphur and asphalt contents are termed "black oils." The Waugh Dome oil has an A.P.I. gravity of 27.8 deg. and a sulphur content of 1.77 percent. The Wertz Dome crude oil has a gravity of 35.2 deg. A.P.I. and a sulphur content of 1.3 percent.

Copies of Bureau of Mines Report of Investigations 3358, Analyses of Crude Oils from Some of the More Recently Discovered Rocky Mountain Fields, by Walter Murphy and H. M. Thorne, may be obtained upon request, without charge, from the Information Division, Bureau of Mines, Washington, D. C.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You'll enjoy the
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when you get to
HOUSTON
The Texas State offers the utmost in comfort and modern luxury. Yet rates are well within modest budgets. For instance, complete luncheon is served in our attractive Mezzanine Dining Room for as little as 65c.
HOUSTON'S NEWEST HOTEL
Tub and Shower in all rooms
LOW AS 2.50 A DAY
B. F. ORR, General Manager

Made Rocky Mountain Representative for American Sand-Banum

C. W. DAVIS

The American Sand-Banum Company, Inc., 9 Rockefeller Plaza, New York City, announces that C. W. Davis has been selected as its representative in the Rocky Mountain states. A stock of Sand-Banum, for boiler and engine treatment, will be carried in Casper, Wyoming, where Davis will make his headquarters.

Executives Completing Plans for New Smith Subsidiary

CARL JOYS

Production and sales plans for the Smith Meter Company, 533 Roosevelt Building, Los Angeles, California, newly-acquired subsidiary of the A. O. Smith Corporation, Milwaukee, Wisconsin, are rapidly nearing completion, according to Carl Joys, vice-president of the parent organization, and Allan Floyd, general manager of the subsidiary.

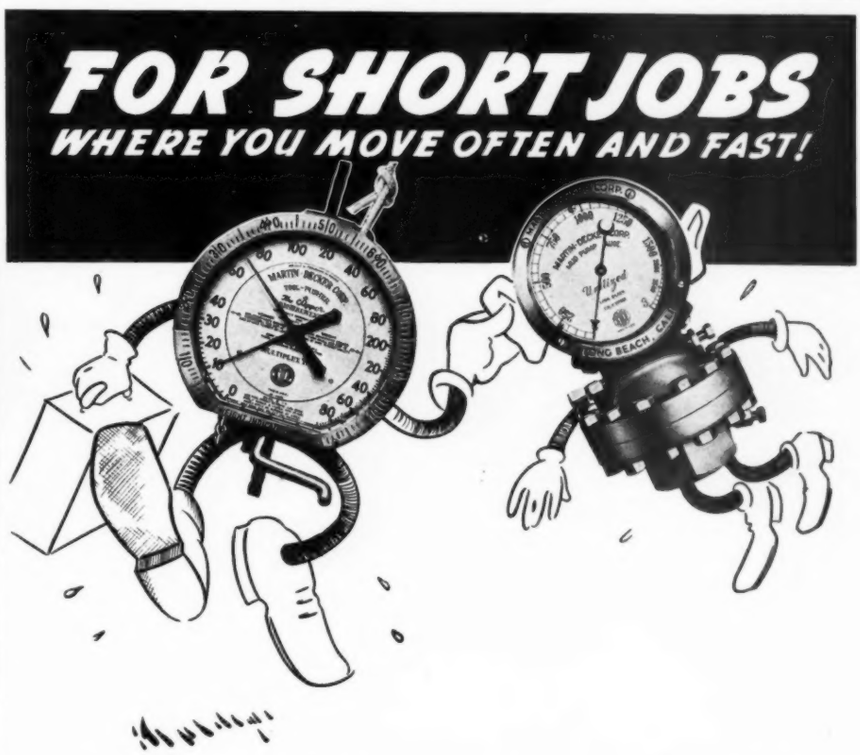
ALLAN A. FLOYD

"The Smith Meter," said Floyd, is a highly engineered mechanism for measuring the flow of liquids. As the use of gasoline and other liquid petroleum products has increased tremendously, so has the problem of quick, accurate measurement become more and more acute. In the old days of the petroleum industry the number of gallons was actually measured by hand, but as the industry speeded up, meters began to be employed. These were largely adaptations of equipment used in other industries and served their purpose well. Our new meter is designed primarily and specifically for the petroleum industry, and to give the speed and accuracy required under present-day circumstances. One of its features is its low resistance to the flow of the liquid being measured. Also, it is practically impossible for either the meter or its indicating device to be tampered with."

Bridgeport Opens New Store at Wichita Falls, Texas

The Bridgeport Machine Company announces the opening of a new branch store at Sixth and Ohio Streets in Wichita Falls, Texas. The new store will operate as a complete distributing branch carrying the full line of Bridgeport rotary and cable tools, rental tools, gumbo buster rotary machinery, drilling muds, pipe and tubular products, used and rebuilt equipment, supplies, and all equipment used in the Wichita Falls area.

W. M. McClure, who has been with the company many years, was transferred from Ft. Worth to take charge of the Wichita Falls branch.



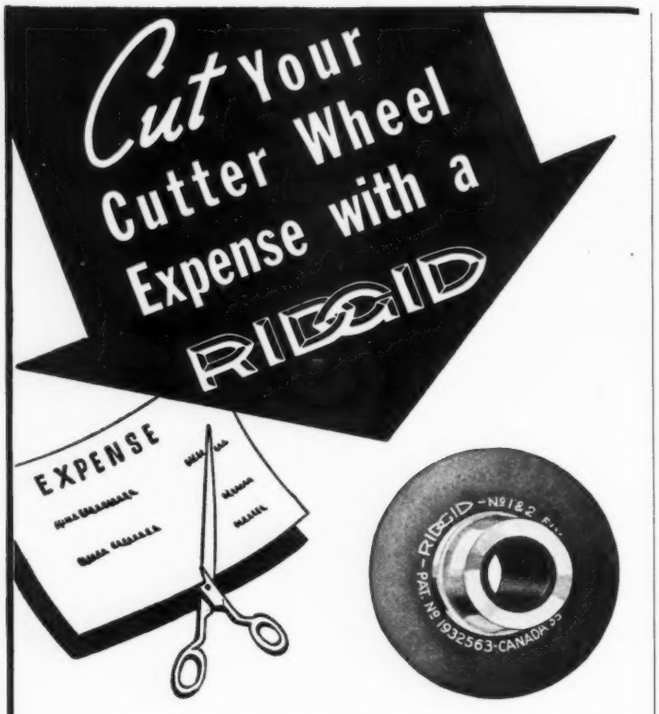
Here's a combination that's ready to move *anywhere* on a moment's notice. Shallow drilling, fishing jobs, redrill work, pulling tubing, setting casing—it makes no difference. This pair is instantly at home on any rig.

The CLIPPER handles the weight indicating work, and does a good job of it, too. Ten interchangeable dials nested in the waterproof case give direct readings in *pounds*, accurately, for any standard stringup with all conventional sized lines. If you prefer readings in *points* there's an eleventh dial on the rim to give you that, too. Supersensitive and regular gauge hands cover *all* types of work. And the weight—only 47 pounds complete!

The UNITIZED MUD PUMP GAUGE handles the pressure indications with double efficiency. It gives extreme sensitivity over the low pressure range of ordinary operations, yet has ample capacity to handle the high pressures of cementing, breaking circulation, etc. Containing Pulsation Damper, Diaphragm Unit and Indicating Gauge in one compact unit, this instrument is as quick to install as a bull plug, and just as easily removed.

Where a chart record is not required, and where installation time is a factor you can't go wrong on this efficient pair. Write today for complete information!

THE WEIGHT INDICATOR
MARTIN-DECKER CORPORATION
LONG BEACH CALIFORNIA
San Joaquin Valley: A. F. McQUISTON, Bakersfield, California
Mid-Continent Distributor: REED ROLLER BIT COMPANY, Houston, Texas



You see at once better cutting and wear because the wheel in a RIDGID is a thin blade, coined out of alloy tool steel, hammered, heat-treated, assembled in a solid hub. Gives you far more cuts per wheel. Assures quicker easier cleaner cuts, practically no burr. Reinforced cutter housing guaranteed not to break or warp, always cuts true. Try one at your Jobber's. Find out why hundreds of thousands of users take pride in owning the RIDGID. For economy and better cutting, buy the better looking RIDGID.

The Ridge Tool Co., Elyria, Ohio

Stop 75% of Your Pipe Wrench Repairs

RIDGID housings guaranteed against break or warp — or we replace free. Entire tool of alloy metals guaranteed. Practically ends repair expense and nuisance of wrenches out of service.

RIDGID PIPE TOOLS

Presents Model Cooling Towers to Engineering Schools

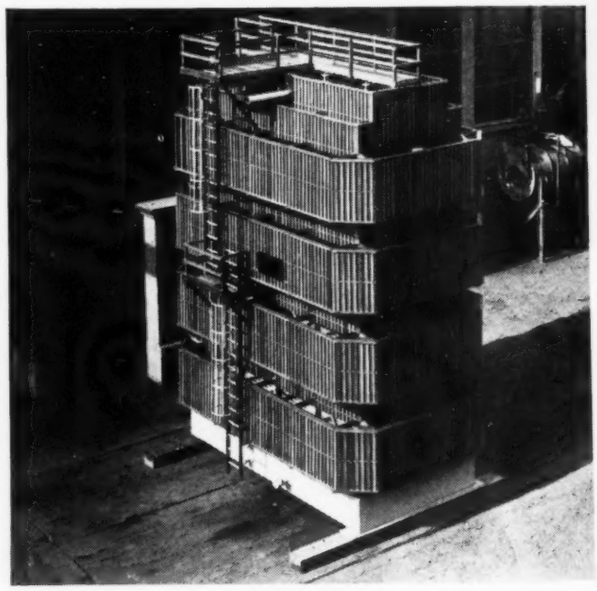
Stimulated by intense interest shown by engineering school faculties and students in modern industrial water-cooling methods, The Fluor Corporation, Ltd., Los Angeles, California, recently built and presented eight nationally-known and universally-recognized engineering schools with ¼-scale working models of The Fluor Standard 4A12 Aerator Type atmospheric cooling towers.

Accurate in every detail, the working models simulate actual Fluor cooling towers in every respect. The premise upon which Fluor engineers worked was as follows: models of cooling towers that would react in the laboratory just as they would in the field would be of great factual interest not only from the standpoint of actual use for cooling purposes in the laboratory, but also in permitting students to avail themselves of first-hand knowledge of cooling methods practiced by industry in the field.

In coöperation with the Pacific Lumber Company, who donated all the redwood, and Crane Company and Chase Brass and Copper Company, who donated pipe and fittings and copper and brass, respectively, used in the models, Fluor engineers developed the models to quarter scale of their standard tower. Dimensions of the model are 4 ft. 6½ in. by 7 ft. 6½ in. by 10 ft., and each weighs 1200 pounds. Identical in every respect to the Fluor tower, except in size, tests proved to the satisfaction of company engineers that the model tower would perform just as standard towers in the field.

In all branches of university engineering and chemistry, the laboratory models will be used by faculty professors, undergraduate students, and graduates engaged in research work.

Recipients of Fluor model towers, according to a list made available by Flour Corporation officials are: California Institute of Technology at Pasadena, Stanford University



at Palo Alto, University of California at Berkeley, all in California; Colorado School of Mines at Golden, Colorado; University of Michigan at Ann Arbor, Michigan; Cornell University at Ithaca, New York; Stevens Institute of Technology at Hoboken, New Jersey; and Georgia School of Technology at Atlanta, Georgia.

California Oil and Gas Association Elects Officers for 1938

F. E. FOSTER

W. H. Geis, president of the Super Asphalt Products Company, was elected president of the California Oil and Gas Association at the December meeting of the association's board of directors. L. P. St. Clair, president of the Union Oil Company of California, and R. E. Collom, vice-president of the Continental Oil Company, were re-elected vice-presidents. H. L. Westbrook, vice-president of the Belridge Oil Company, was re-elected treasurer for his 13th successive term. F. E. Foster continues as managing director and D. S. Kilgour continues as assistant manager.

W. H. GEIS

Directors elected for 1938 include: S. Belither, president, Shell Oil Company; Cyrus Bell, president, Perkins Cementing, Inc.; R. A. Broomfield, executive vice-president, Barnsdall Oil Company; Arthur G. Brown, district sales manager, Columbia Steel Company; Mark C. Brown, vice-president, Hillman-Kelly, Inc.; E. B. Gilmore, president, Gilmore Oil Company; Wm. F. Humphrey, president, Tide Water Associated Oil Company; C. S. Jones, president, Richfield Oil Corporation; Ralph B. Lloyd, president, Lloyd Corporation; Alexander B. Macbeth, president, Southern California Gas Company; A. C. Mattei, president, Honolulu Oil Corporation; C. E. Olmsted, president, The Texas Company (California); W. H. Reid, president, Hancock Oil Company of California; William Reinhardt, vice-president, Union Pacific Railroad; F. C. Ripley, manager, Chanslor-Canfield Midway Oil Company; C. P. Watson, vice-president, Seaboard Oil Corporation of Delaware; A. L. Weil, president, General Petroleum Corporation of California.

R. E. COLLOM

L. P. ST. CLAIR

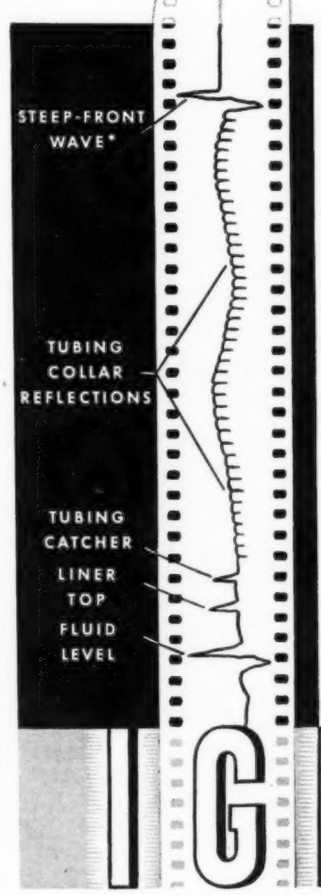
D. S. KILGOUR

INTRODUCING

the Electrical

ECHO-METER

for accurate fluid level determinations



Location of the Fluid Level in a pumping well is of vital importance! To get maximum production and greatest pumping efficiency, it is necessary to maintain the proper Fluid Level. Maximum drainage into your well is obtained with a low Fluid Level. Don't let the oil drain to adjacent wells. • With the Electrical ECHO-METER, an *accurate operating* Fluid Level Determination can now be furnished *in a few minutes* and *at a small cost, without shutting down the pump, pulling the rods or tubing, or interfering with production in any way.* • Location of the Fluid Level is obtained by recording on a film the time required for a Steep Front Wave* to travel from the casing head to the Fluid and return. In addition to the reflections from the Fluid Level, other reflections are obtained from tubing collars, tubing catchers, liner tops, etc., providing a complete record.

EXTREMELY LOW IN COST

The average cost for a single Fluid Level Determination with the ECHO-METER is only $25.00 per well, plus 8 cents per mile for the truck; additional wells in the same day result in a further saving. • For Fluid Level location, use ECHO-METER Service. It's *Accurate, Inexpensive, Safe* and *Fast*. It's Better!

**Greatest accuracy* is assured with a Steep Front Wave Sonic measuring device on which there are United States Patents pending covering the methods and apparatus.

IGI

INTERNATIONAL *Geophysics, Inc.*

ORGANIZED IN 1920

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During 1938 form the HABIT

of specifying B-M-W Products

- ADMORE Insert Pump Anchors;
- BALLS and SEATS (made for every pumping service);
- NEILSON Tools (Safety Sucker Rod Hooks, Tubing Hooks, Rod Elevators, Sucker Rod Sockets, etc.);
- ADMORE Liner Barrels;
- TEX TYPE Plunger Fittings and Valves;
- COLLINS Belt Clamps.

THE B-M-W ADMORE INSERT PUMP ANCHOR

shown at the left, Patent No. 2,027,783, packs off and holds down directly in the tubing itself. Saves on sucker rods and other equipment where fluid level is high and well can be pumped above bottom. No working barrels. No seating nipples. No mechanical shoes. No pulling of tubing. Complete data on request.

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BRADFORD MOTOR WORKS INC.

OIL WELL SUPPLIES

BRADFORD, PA. — TULSA, OKLA.

360 TONS CAPACITY

DOUBLE DECK

Type EB

REGAN CROWN BLOCK

Regan Type EB Crown Block is similar in design to Type B but with much heavier construction. All castings with exception of sheaves and minor parts eliminated. Sheave beams supporting bearing built up of rolled steel plates. Available in 5, 6, and 7 sheave units with 48" and 36" diameter sheaves. Rated safe load capacity to 360 tons with factor of safety of three and one-half.

Ask for Bulletin or refer to 1938 Composite Catalog.

Regan Forge & Engineering Co.

Plant and General Offices — San Pedro, Cal. P. O. Box 150

Mid-Continent Office—1502 Maury Street, Houston.
Oklahoma—Mid-Co Tool & Supply Co., Oklahoma City.
Kansas Representative—Bovaird Supply Co., Wichita.
New York City Office—17 Battery. G. R. Woods, Mgr.

Cutlip Promoted by Union Wire Rope

The Union Wire Rope Corporation, Kansas City, Missouri, has announced the appointment of H. R. Cutlip as assistant to H. R. Gruber, manager of oil-country sales. Cutlip has been the company's division sales manager for Texas, with headquarters at Dallas, but will now have his headquarters at 601 Beacon Building, Tulsa.

●

Texasteel Manufacturing Company Formed

The Texasteel Manufacturing Company has been organized and on January 1 took over the plant, assets, and management of the oil well supply department of the Texas Steel Company, Fort Worth, Texas. The new company was organized under the laws of Texas with a fully paid up capital stock of $300,000, represented by 3000 shares of common stock with a par value of $100 each.

JUDGE GEO. W. ARMSTRONG

The company will engage in the manufacture of the complete line of oil-field pumping equipment formerly manufactured by the Texas Steel Company. This consists generally of all standard sizes and various types of high-tensile and low-metalloid electric-steel sucker rods, electric-steel pull rods, a complete line of double- and single-crank pumping units, pumping jacks, back-side stroke-post assemblies, and necessary rod line surface equipment, as well as a full line of miscellaneous items.

A. J. ARMSTRONG

GEO. W. ARMSTRONG, JR.

JESS W. EMERY

JOHN F. FOSTER

The directors of the new company are Judge George W. Armstrong, president; A. J. Armstrong, vice-president and general manager; George W. Armstrong, Jr., vice-president; Jess W. Emery, vice-president and general sales manager; and John F. Foster, secretary-treasurer.

Judge George W. Armstrong also is president of the parent organization, The Texas Steel Company.

M. R. Shaffer Dies from Throat Ailment

M. R. Shaffer, manager of production for the Cities Service Oil Company, Bartlesville, Oklahoma, died in a Kansas City hospital January 11 from a throat ailment.

M. R. SHAFFER

Born in Oil City, Pennsylvania, 46 years ago, Shaffer first became connected with the petroleum industry as a roustabout and pumper in the fields near Eldorado, Kansas, in 1910. He was with the old Roxana Petroleum Corporation, now the Shell, before going with the Empire as production superintendent. Later he was advanced to the post of manager of production.

He was a member of the American Petroleum Institute and served on the advisory committee of the division of production and previously was chairman of the same committee for the Mid-Continent district, and presided at the meeting of the officers in connection with the Mid-Continent district convention held in Tulsa in February, 1936, and had planned to act similarly at the forthcoming district convention at Amarillo.

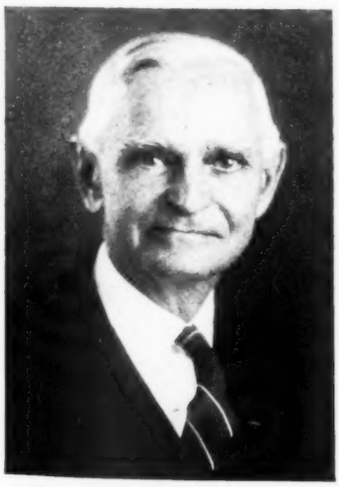
Clark Bros. Open Dallas Office

Clark Bros. Company, Olean, New York, have opened a branch office in Dallas, Texas, at 820 Wilson Building. Wm. A. Roever is in charge and will have as his territory North Texas, West Texas, East Texas, and North Louisiana.

WM. A. ROEVER

Roever graduated from Washington University, St. Louis, Missouri, in 1930 with the degree of mechanical engineer. He was with the Continental Supply Company from 1930 to September 1, 1937.

E. P. Dillman Retires



E. P. DILLMAN

E. P. Dillman, vice-president and director of sales of the Wyatt Metal and Boiler Works, Dallas, Texas, retired January 1, after 20 years' service with the company, and will devote much of his time in the future to travel. The first stop on his itinerary will be Florida where he and Mrs. Dillman will spend the remainder of the winter.

Dillman has a host of friends throughout the industry who wish him many happy years in pursuit of his avocation, travel.

ENSIGN GAS Carburetors

ARE STANDARD EQUIPMENT ON THESE LEADING POWER UNITS

ALLIS-CHALMERS • BUDA • BUFFALO
CLIMAX • CONTINENTAL • CHRYSLER
HALL-SCOTT • HERCULES • INTERNATIONAL-HARVESTER • JOHN DEERE • KOHLER
LE ROI • MINNEAPOLIS-MOLINE • OLIVER
STERLING • WAUKESHA • WHITE • WILSON

Future advertisements will show ENSIGN equipment on various models of engines made by the above manufacturers. Watch for them!

ENSIGN CARBURETOR COMPANY, LTD.

LOS ANGELES • DALLAS • CHICAGO

ENSIGN pioneered the development of carburetting equipment for Natural Gas, Butane and combinations of these two fuels with Gasoline.

Improved SHULL SWAB

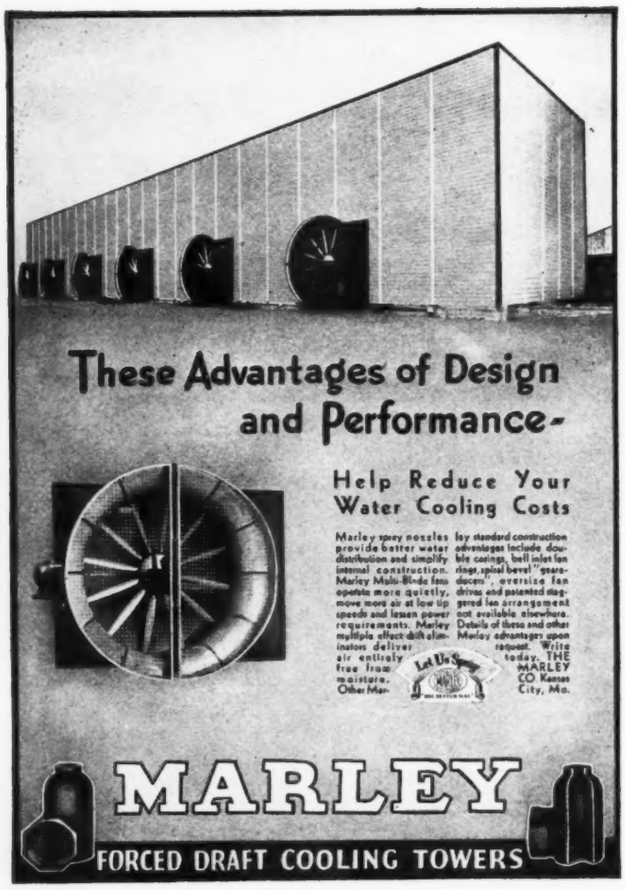
for Casing and Tubing

Introducing the most advanced design, the Shull Improved Swab permits a quicker, more thorough swabbing job than ever before possible. It is adjustable to any degree of expansion or wiping pressure desired. Operation: When running into the hole, the rubber assembly is "up" against the shoulder of the Mandrel Shank. The bottom nut is off its seat and permits free passage of the fluid along the channels of the Mandrel stem through the Rubber Assembly. When bottom is reached, the slidable rubber assembly drops, and the bottom nut closes the fluid channels at the seat.

Mail Coupon for Literature

Shull Perforating Co., Inc.,
2750 Cherry Ave., Long Beach, Calif.
Send literature describing Shull Swab and other products.

Name .....
Address .....
City ..... *State* .....



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Enclosed is $_____ for a _____ year (new) (renewal) subscription.

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Hold Golf Tournament

Reading from left to right are the following members of the Axelson Manufacturing Company's organization: J. C. Axelson, A. Zwerneman, T. Rauworth, H. D. Collins, W. F. Goertz, and H. S. Kelley

Inaugurating the first of a series of semi-annual golf tournaments, members of the Axelson Manufacturing Company's sales department at Los Angeles played the Rio Hondo course December 18. The tournament, under the direction of R. M. Humphreys and Alvin Zwerneman, brought together all of Axelson's California store men and salesmen, as well as executives of the company and members of the sales and order departments.

Tied for first place were Alvin Zwerneman and Ray Conger. G. A. Axelson, J. C. Axelson, and Abe Haglund were among the runners up.

Bennett Goes with Sunray; McCutchin Succeeds Him with British American

VAN D. BENNETT

Van D. Bennett has resigned as chief petroleum engineer of the British American Oil Producing Company, Tulsa, Oklahoma, to become chief consulting engineer of the Sunray Oil Company. His headquarters will continue to be in Tulsa, although his territory will include Oklahoma, Texas, Kansas, and California. John A. McCutchin, petroleum engineer with the British American, has been named to succeed Bennett.

Prior to joining the staff of the British American in mid-year 1936, Bennett was assistant production superintendent of the Derby Oil Company in Kansas, and before that was a petroleum engineer with the same company.

JOHN A. McCUTCHIN

McCutchin joined the British American staff in November, having been with the Shell Petroleum Corporation since 1933. With the latter company he first was district exploitation engineer in the Seminole area of Oklahoma, served in a similar capacity at McPherson, Kansas, and at the time of his resignation was an evaluation engineer in the Texas Panhandle area.

Book Reviews

Illinois Mineral Industry in 1936, by Walter H. Voskuil, Alma R. Sweeny, and W. A. Newton. Report of Investigations No. 46, Illinois State Geological Survey, 65 pp., 9 illus., 53 tables.

The sections of this volume that are of most interest to persons engaged in the oil industry are those which contain data pertaining to production of fuels in Illinois and consumption of fuels in that and nearby states. Production of both coal and petroleum in 1936 exceeded that of 1935. Increased industrial consumption was responsible for the increased demand for coal. Fuel oil and gas consumption increased as these substances were substituted for coal for domestic heating in 1935, the last year for which figures are available.

* * *

The Reactions of Pure Hydrocarbons in the Presence of Aluminum Chloride, by Gustav Egloff, Edith Wilson, George Hulla, and P. M. van Arsdell. Reprinted from Chemical Reviews, Vol. 20, No. 3, June, 1937. 66 pp.

This paper, presented before the Division of Organic Chemistry of the American Chemical Society, includes discussion of the actual and theoretical mechanisms, rates, and products of reactions involving all classes of hydrocarbons in the presence of aluminum chloride and also tables showing experimental conditions and results. The arrangement is convenient for quick reference and the subject matter is treated concisely but adequately.

Malcolm Black Sales Manager of New District

MALCOLM BLACK

Malcolm Black has been appointed district sales manager by Manning, Maxwell and Moore, Inc., of a newly-created South Central District with headquarters at 533 Mayo Building, Tulsa, Oklahoma.

Black has represented this company, whose headquarters are Bridgeport, Connecticut, as sales engineer of the Tulsa territory for several years.

Houston Oil Show Declares Refund

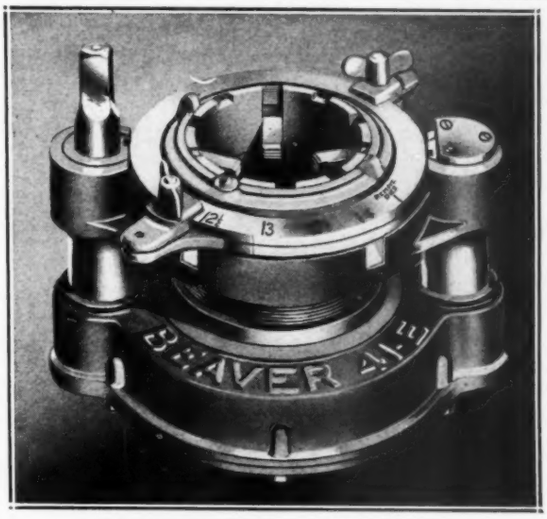
In accordance with the non-profit policy of the Oil-World Exposition Association, John R. Suman, vice-president of Humble Oil and Refining Company and president of the association, announces that a 20 percent refund has been made to all those who exhibited at the 1937 exposition.

The next oil show in Houston will not be held until 1939. The definite dates for this exposition will be decided by the board of directors at a meeting to be held early in 1938. The time, however, will be in the spring instead of in October as it was in 1937.

Kibele Names Pacific Coast Distributor

Kibele Manufacturing Company, Dallas, Texas, announces that it has placed the distribution of its products on the Pacific Coast in the hands of the Howard Supply Company, 5125 Santa Fe Avenue, Los Angeles. Products manufactured by the Kibele company comprise tubing catchers, swabs, boiler feed pump pistons, and packers.

H. E. Howard is president of the California company and L. George Trembley is vice-president and sales manager.



AN OIL FIELD FAVORITE

BEAVER NO. 41-E—2½ TO 4-INCH

Even though Beaver makes also the "separate die-type" of geared threader possessed of many exclusive advantages—Beaver No. 41-E using 1 set of dies is popular in oil fields throughout the world because it cuts standard, under or over-size, to meet variations in fittings without affecting the length of thread—thus assuring tight joints. The gears are fully enclosed and packed in graphite grease. Sand, chips or other foreign matter cannot get into the gear case to damage the gear and pinion. Thus, the principal cause of the trouble in geared tools is entirely eliminated. An exceptionally sturdy tool—ideally suited for oil field use. Price No. 41-E, complete, $50.00 through your supply house. Write for catalog.

BEAVER PIPE TOOLS

138 PETROL AVENUE WARREN, OHIO

WEBSTER SAYS:

re-pel', ri-pel', v. t. To drive or keep away; check; repulse.

THAT'S WHY HOUGH CALLS THIS BALL AND SEAT

"REPELEX"

"REPELEX" . . . because it gives MAXIMUM RESISTANCE to rust, abrasion, and cutting action of sand . . . made of Stainless Steel. Six other specialized types at oil-field distributors. The Charles N. Hough Mfg. Co., Franklin, Pa., and Tulsa, Okla.

HOUGH

Specialized **BALLS & SEATS**

WHERE DEPENDABILITY CANNOT BE OVERLOOKED

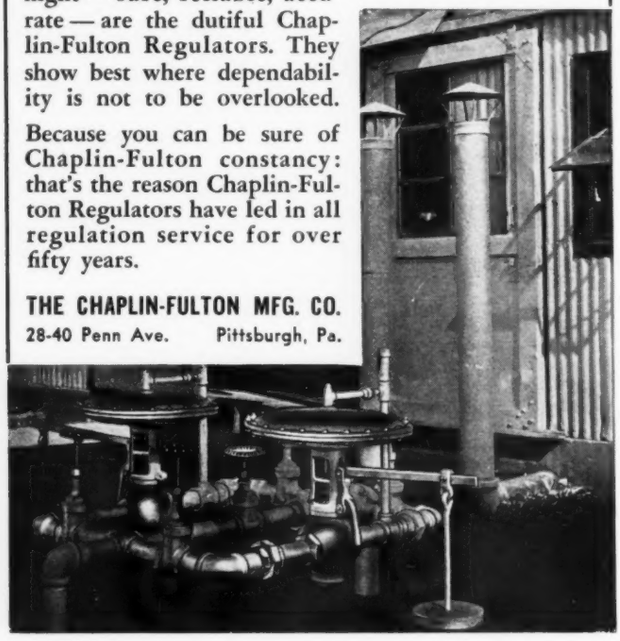
Nothing conspicuous; nothing to catch your eye and make you stop; but there on the job serving you day and night — sure, reliable, accurate — are the dutiful Chaplin-Fulton Regulators. They show best where dependability is not to be overlooked.

Because you can be sure of Chaplin-Fulton constancy: that's the reason Chaplin-Fulton Regulators have led in all regulation service for over fifty years.

THE CHAPLIN-FULTON MFG. CO.
28-40 Penn Ave. Pittsburgh, Pa.

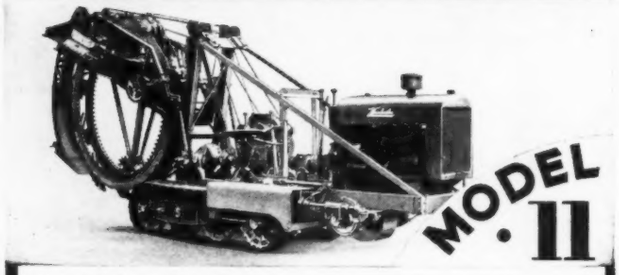
CF

Chaplin-Fulton 2" Low Pressure Cut-off Regulators on fuel line to compressors at Fairfax, Okla.



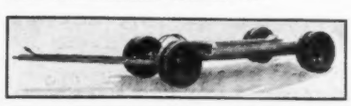
A Buckeye DITCHER for TRENCH 10" to 22" WIDE

• OVERALL WIDTH OF MACHINE ONLY 52"
• EASILY HANDLED IN CRAMPED QUARTERS



MODEL 11

Big ditcher efficiency and economy comes to the small ditching field in the Buckeye Model 11. Built for steady, time saving operation, with speed for easy going and rugged strength for the toughest jobs – features of Buckeye engineering that always save you money on any job. Before you buy a ditcher, be sure you have the facts about Model 11.



This specially designed Buckeye trailer is for quick and easy transportation of the Model 11. The ditcher climbs onto the trailer under its own power, fully assembled.

THE BUCKEYE TRACTION DITCHER CO., FINDLAY, OHIO

Trade Personals

HUBERT DAVID COLLINS has been appointed field engineer and special sales representative for the Mid-Continent area by the Axelson Manufacturing Company of Los Angeles, California. He will make his headquarters at Tulsa, Oklahoma.

JOHN F. CUNNINGHAM, supervisor of production for the General Electric Company since September, 1931, has been appointed assistant to the vice-president in charge of manufacturing, succeeding MYRON F. SIMMONS, who is retiring.

WALTER WELLS, of the Lane-Wells Company, has returned to Los Angeles from a trip to England and the Continent. He was accompanied by Mrs. Wells.

W. B. SHARP, president of the Mission Manufacturing Company, has been elected a member of the board of directors of the Houston, Texas, Chamber of Commerce, and named chairman of the manufacturers' committee of that body.

W. H. FRENCH is the new sales representative in the Tulsa territory for the Guiberson Corporation, Dallas, having succeeded J. B. GUFF, resigned.

RALPH C. CHAMPLIN has been elected a vice-president of the Ethyl Export Corporation, foreign subsidiary of the Ethyl Gasoline Corporation. Since joining the Ethyl organization early in 1937, Champlin has been chairman of the coördinating committee.

CHARLES E. WILSON of Bridgeport, Connecticut, vice-president in charge of the General Electric Company's appliance and merchandise department since 1930, has been elected executive vice-president of the company, a new position, it has been announced by President GERARD SWOPE. At the same time, Swope announced the election of PHILIP D. REED as assistant to the president. Mr. Reed entered the employ of General Electric in 1926.

R. A. MCCARTY has been appointed manager, Small Motor Division, Westinghouse Electric and Manufacturing Company, according to a recent announcement by Vice-President RALPH KELLY. He succeeds R. F. FRENGER. McCarty will have his headquarters at the company's plant in Lima, Ohio.

ABBOTT F. RIEHLE has been appointed sales manager of the Smootharc Welder and Welding Electrode Division of the Harnischfeger Corporation, Milwaukee, Wisconsin. Riehle for ten years was in charge of the sales and management of the Riehle Brothers Testing Machine Company of Philadelphia, which was later taken over by American Machine and Metals, Inc., where he continued in charge of sales.

GEORGE CAMPBELL, manager of the Schenectady local sales office of the General Electric Company, assumed the added responsibilities of the management of the Syracuse office on January 1, according to an announcement by H. H. BARNES, JR., commercial vice-president.

TRADE LITERATURE

THE BROWN INSTRUMENT COMPANY, Wayne and Roberts Avenues, Philadelphia, Pennsylvania, has published a catalog on the Brown automatic boiler regulation system. The steam damper regulator (master) and over-fire control described in this catalog as part of the Brown automatic boiler regulation system are manufactured by the National Regulator Company, Chicago, now a Division of Minneapolis-Honeywell Regulator Company.

●

"HOW TO HANDLE LOADS SAFELY," a 16-page booklet issued by the Macwhyte Company, Kenosha, Wisconsin, pictures braided wire rope slings used effectively for handling materials quickly and safely. A copy will be sent free to those interested.

●

"OIL FIELD EQUIPMENT" is the title of a new 24-page bulletin, No. 163, dealing with rotary-drilling rigs, mud screens, and other oil-field equipment developed and built by Allis-Chalmers Manufacturing Company, Milwaukee, Wisconsin. A copy may be obtained by getting in touch with the nearest Allis-Chalmers district office or any supply company.

●

THE RECTOR WELL EQUIPMENT COMPANY, INC., Fort Worth, Texas, has issued its 1938 catalog. The publication illustrates and fully describes the company's line of equipment, particularly the Rectorhead. Those desiring a copy of the catalog can obtain one free by writing the company.

●

THE SECOND ANNUAL HANDBOOK AND CATALOG of Modern Plastics has been issued by the Breskin and Charlton Publishing Corporation, New York City. The volume should prove of interest to those interested in the fundamental as well as the technical aspects of plastics. New developments, both in materials and equipment, graphic illustrations that indicate the use each type of plastic is best qualified to meet, and technical data for technicians, designers, and engineers all are presented.

●

"HOW TO CHANGE OVER TO WELDED DESIGN FOR PROFITS" is the title of a new 32-page, profusely illustrated bulletin published by The Lincoln Electric Company, Cleveland, Ohio. Intended as an aid in applying electric welding to the design of machines and machinery structures, the new bulletin sets forth the experiences of many manufacturers who have redesigned their products for arc-welded construction.

●

A NEW 28-PAGE PYROMETER CATALOG, No. 1101D, has been published by C. J. Tagliabue Manufacturing Company, Park and Nostrand Avenues, Brooklyn, New York. This book describes and illustrates many features of Tag Celectray indicating, recording, and controlling pyrometers and resistance thermometers, which utilize a phototube, mirror galvanometer, and a beam of light.

●

THE LATEST CATALOG concerning Fast's self-aligning couplings, issued by Koppers Company's Bartlett Hayward Division, Baltimore, Maryland, is available free to interested parties.

Gotkool
WATER CANS & COOLERS
GOTT Water Coolers are the convenient way to keep drinking water handy to the worker, protect it from impurities. Their exclusive construction keeps water cool for long periods. Snug fitting large removable top, handy non-leaking push button faucet. GOTT Water Cans for handy field use. Your Supply Store has them, get one today!
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Made in 3, 5, 8, 10, and 20 gallon sizes.
H. P. GOTT MFG. CO.
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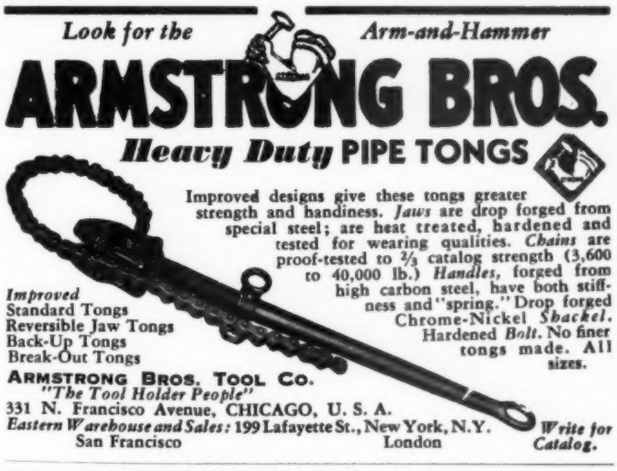
KEEP PURE DRINKING WATER ALWAYS HANDY


Look for the Arm-and-Hammer
ARMSTRONG BROS.
Heavy Duty PIPE TONGS
Improved designs give these tongs greater strength and handiness. Jaws are drop forged from special steel; are heat treated, hardened and tested for wearing qualities. Chains are proof-tested to 2/3 catalog strength (3,600 to 40,000 lb.) Handles, forged from high carbon steel, have both stiffness and "spring." Drop forged Chrome-Nickel Shackel. Hardened Bolt. No finer tongs made. All sizes.
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FOR SUBSCRIBERS
to The Petroleum Engineer

..who find it convenient to file portions of the magazine for ready reference, we have had manufactured a special three-ring binder. It is a standard size, flexible, durable leatheroid binder with dividers for each division of the industry. The binder may be had for $1.25, express paid, by filling in the attached coupon and mailing it to us with your remittance.

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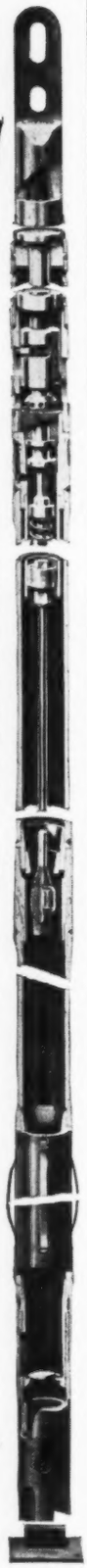
Check your division: ☐ Producing ☐ Refining ☐ Natural Gasoline ☐ Supply ☐ Manufacturing

HOW TO WIN DOLLARS AND INFLUENCE PRODUCTION



Oil wells, like humans, respond to proper treatment. When production is off because of junk plugged perforations, or bad sand conditions, it's a cinch for The Cavins Hydraulic Suction Bailer and Fishing Tool to bring them back to par. There's no gambling with The Cavins, its down-right dependability, proved through many years, and thousands of tough jobs, makes it a safe bet for bailing, fishing and washing perforations. Where others failed The Cavins made good, because it's scientifically correct in principle and construction.

You can depend on The Cavins. It's a necessary tool in every rig.

Send for Bulletin No. 38, giving detailed information.

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San Fernando, TRINIDAD, B.W.I.

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A DAILY REFERENCE FOR OPERATING MEN

INSTALLMENT NO. 8

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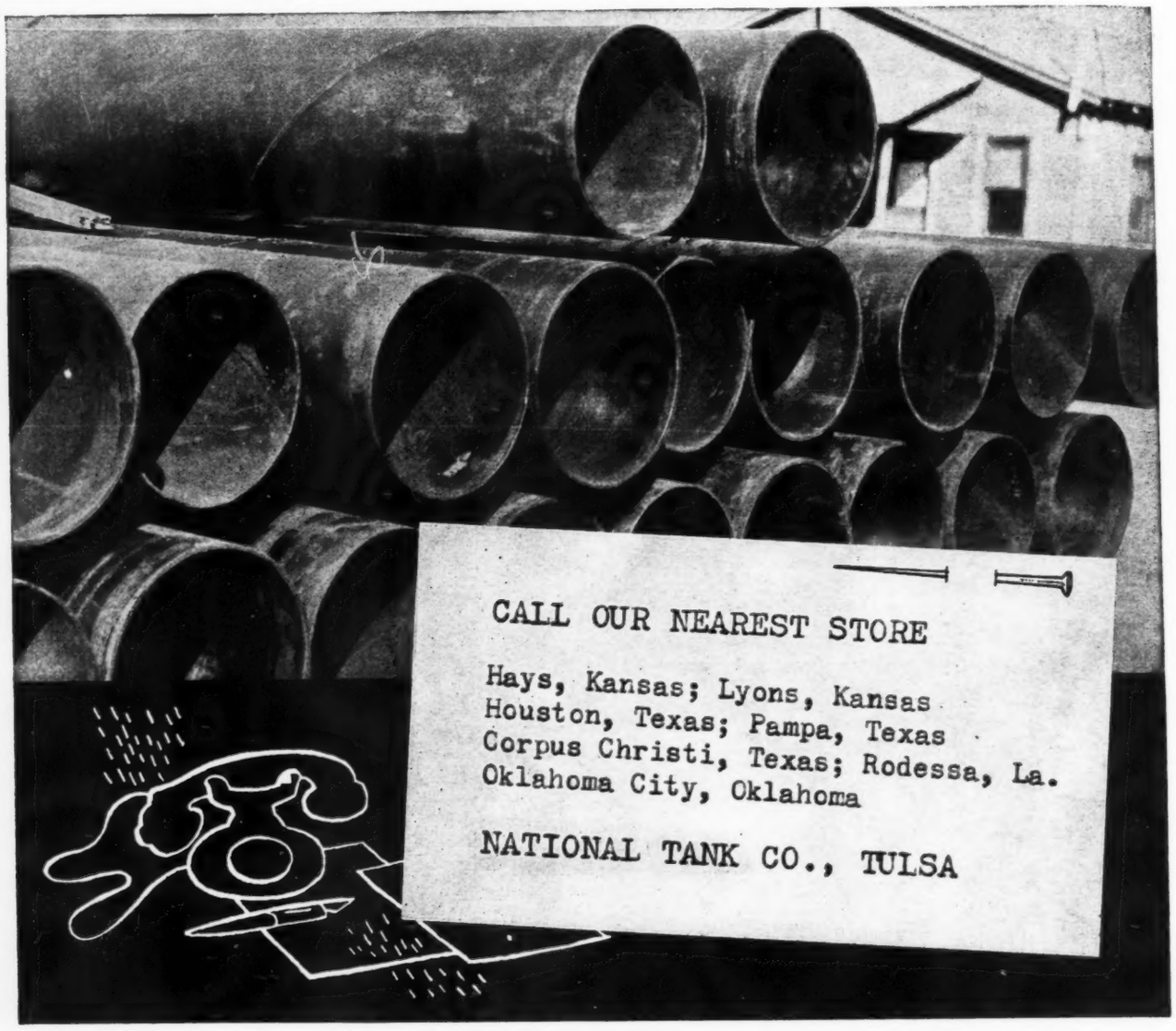
STRENGTH OF LIGHT-WEIGHT SURFACE CASING

Casing size, in.		Weight, lb. per ft.	Thickness		Bursting strength, lb. per sq. in. S. F. = 2	Limiting length of string, ft., subject to collapse[1]. S. F. = 2	
O. D.	I. D.		Gauge	In.		10 lb. per gal. fluid inside 14.5 lb. per gal. fluid outside	Dry inside Fresh water outside
8⅝	8.2813	16.2	8	.171875	598	850	455
	8.25	17.5	7	.1875	652	1080	595
10¾	10.4063	20.3	8	.171875	480	440	235
	10.375	21.8	7	.1875	523	570	305
	10.3125	25.3	5	.21875	610	910	485
	10.25	28.7	3	.25	698	1360	725
13	12.6563	24.3	8	.171875	397	250	135
	12.625	26.4	7	.1875	428	330	175
	12.5625	30.8	5	.21875	505	530	280
	12.50	34.8	3	.25	578	780	410
13⅜	13.0313	25.7	8	.171875	385	225	120
	13.00	27.2	7	.1875	421	295	160
	12.9375	31.6	5	.21875	491	470	250
	12.875	35.8	3	.25	561	700	370
16	15.6563	30.6	8	.171875	323	135	70
	15.625	32.6	7	.1875	352	175	95
	15.5625	37.9	5	.21875	411	275	150
	15.50	43.2	3	.25	469	410	220
18⅝	18.2813	35.6	8	.171875	278	85	46
	18.250	38.3	7	.1875	303	110	60
	18.1875	44.1	5	.21875	353	180	96
	18.125	50.7	3	.25	403	265	140
20	19.6563	38.5	8	.171875	258	70	40
	19.625	41.0	7	.1875	282	90	50
	19.5625	47.5	5	.21875	328	145	80
	19.50	54.0	3	.25	375	215	115
21½	21.1563	40.5	8	.171875	240	55	30
	21.125	44.0	7	.1875	261	72	40
	21.0625	51.0	5	.21875	305	115	60
	21.00	58.0	3	.25	350	170	90
24½	24.1563	46.4	8	.171875	210	35	20
	24.125	51.2	7	.1875	230	48	25
	24.0625	58.2	5	.21875	269	77	40
	24.00	66.2	3	.25	306	115	60

[1]Collapsing pressure based on Stewart formula.

SAVE UP TO 37%
WITH ARMCO SURFACE CASING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NATIONAL TANK CO., TULSA

● Here at last is an improved lightweight casing that enables you to save up to 37 per cent on the cost of *surface* pipe that is cemented-in and never reclaimed.

Scientifically designed for the requirements of different string lengths, Armco Spiral Welded surface casing is easy to handle and set. No special expensive ends are needed for tongs, slips or elevators. And since the ends of the pipe are cut perfectly square, aligning in the hole is greatly simplified.

You can obtain Armco surface casing with economical slip joint couplings for field welding or with A.P.I. threaded ends and collars. Just write, telephone, or wire your needs to the nearest store of our distributor. Or address: The American Rolling Mill Co., Pipe Sales Div., 703 Curtis St., Middletown, Ohio: 538 Mayo Bldg., Tulsa, Okla.

ARMCO

SURFACE CASING

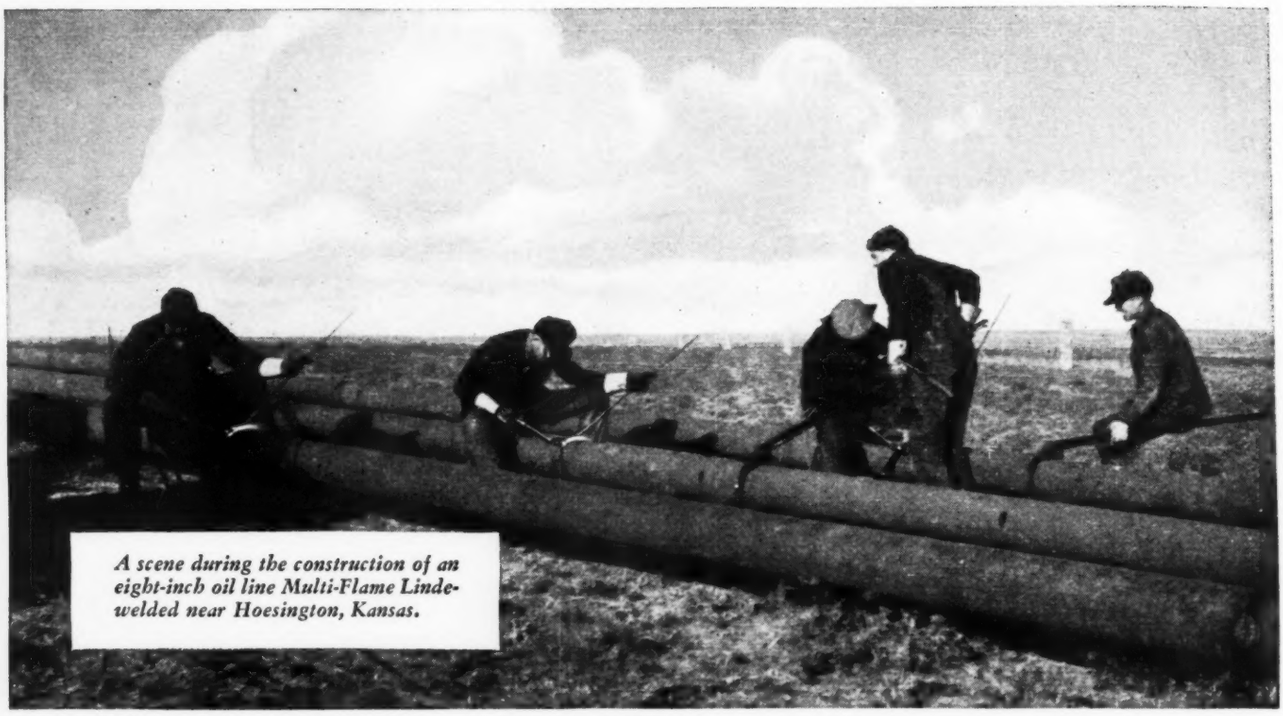
DISTRIBUTED BY NATIONAL TANK CO., TULSA, OKLAHOMA, AND BRANCHES

PRESSURE DROP, LB. PER SQ. IN. PER MILE OF 8-in.[1] PIPE LINE (Oil of 20° A.P.I.)

Quantity of 20° A.P.I. oil, bbl. per hr.	Viscosity of oil, Saybolt Universal seconds										
	140	160	180	200	220	240	260	280	300	320	340
350	5.79	6.01	6.22	6.40	6.57	6.74	6.90	7.04	7.17	7.29	7.41
360	6.08	6.32	6.53	6.72	6.90	7.08	7.24	7.39	7.53	7.66	7.78
370	6.38	6.63	6.84	7.05	7.23	7.42	7.59	7.75	7.90	8.04	8.17
380	6.68	6.94	7.17	7.39	7.58	7.77	7.95	8.12	8.27	8.42	8.56
390	6.98	7.26	7.50	7.73	7.93	8.12	8.32	8.49	8.66	8.81	8.95
400	7.31	7.59	7.84	8.08	8.29	8.49	8.69	8.87	9.05	9.21	9.36
410	7.63	7.92	8.19	8.43	8.65	8.86	9.07	9.26	9.44	9.61	9.77
420	7.96	8.26	8.54	8.79	9.02	9.23	9.45	9.66	9.84	10.02	10.19
430	8.30	8.61	8.89	9.16	9.39	9.62	9.84	10.06	10.25	10.43	10.62
440	8.64	8.95	9.26	9.54	9.78	10.01	10.24	10.46	10.67	10.86	11.04
450	8.97	9.30	9.61	9.90	10.16	10.40	10.64	10.86	11.08	11.28	11.47
460	9.32	9.67	9.99	10.29	10.56	10.81	11.05	11.28	11.50	11.71	11.91
470	9.68	10.05	10.37	10.68	10.96	11.22	11.48	11.71	11.95	12.16	12.37
480	10.04	10.42	10.76	11.08	11.37	11.64	11.90	12.14	12.38	12.62	12.83
490	10.41	10.81	11.15	11.48	11.79	12.07	12.33	12.59	12.83	13.07	13.30
500	10.79	11.19	11.56	11.89	12.21	12.51	12.77	13.04	13.29	13.53	13.77
510	11.16	11.59	11.96	12.31	12.64	12.95	13.22	13.49	13.74	14.00	14.25
520	11.54	11.98	12.38	12.74	13.07	13.40	13.67	13.95	14.22	14.47	14.73
530	11.93	12.38	12.80	13.17	13.50	13.84	14.14	14.42	14.70	14.96	15.23
540	12.31	12.79	13.22	13.59	13.94	14.28	14.59	14.89	15.17	15.44	15.71
550	12.70	13.21	13.64	14.03	14.39	14.75	15.07	15.37	15.67	15.93	16.21
560	13.11	13.63	14.09	14.48	14.85	15.22	15.55	15.86	16.16	16.43	16.72
570	13.52	14.06	14.52	14.93	15.31	15.68	16.04	16.36	16.66	16.95	17.25
580	13.94	14.49	14.97	15.39	15.79	16.16	16.53	16.86	17.17	17.48	17.77
590	14.37	14.92	15.41	15.86	16.26	16.66	17.03	17.37	17.69	18.01	18.30
600	14.79	15.37	15.87	16.34	16.75	17.15	17.53	17.89	18.21	18.54	18.84
610	15.22	15.82	16.34	16.82	17.24	17.65	18.05	18.40	18.76	19.08	19.39
620	15.67	16.26	16.81	17.30	17.74	18.15	18.56	18.94	19.29	19.63	19.95
630	16.10	16.72	17.29	17.79	18.24	18.67	19.07	19.47	19.84	20.18	20.52
640	16.54	17.17	17.77	18.27	18.74	19.17	19.59	20.00	20.37	20.71	21.07
650	17.00	17.64	18.25	18.77	19.27	19.70	20.13	20.53	20.94	21.29	21.64
660	17.45	18.13	18.74	19.29	19.78	20.23	20.68	21.09	21.49	21.87	22.22
670	17.91	18.59	19.23	19.79	20.32	20.76	21.22	21.65	22.06	22.45	22.81
680	18.38	19.09	19.74	20.30	20.84	21.32	21.77	22.21	22.64	23.04	23.41
690	18.86	19.58	20.23	20.83	21.39	21.86	22.33	22.78	23.22	23.63	24.01
700	19.33	20.08	20.75	21.36	21.92	22.42	22.91	23.37	23.80	24.23	24.62
710	19.82	20.58	21.25	21.90	22.48	23.00	23.48	23.95	24.40	24.84	25.24
720	20.32	21.09	21.78	22.45	23.02	23.57	24.06	24.54	25.01	25.44	25.88
730	20.81	21.60	22.31	23.00	23.58	24.15	24.64	25.12	25.61	26.08	26.50
740	21.29	22.10	22.83	23.53	24.14	24.72	25.22	25.72	26.20	26.68	27.11
750	21.78	22.61	23.38	24.09	24.71	25.31	25.82	26.33	26.83	27.32	27.74
760	22.30	23.14	23.93	24.65	25.29	25.90	26.43	26.96	27.46	27.94	28.38
770	22.83	23.66	24.47	25.21	25.87	26.50	27.04	27.56	28.08	28.57	29.04
780	23.33	24.21	25.04	25.78	26.48	27.10	27.68	28.19	28.72	29.21	29.71
790	23.86	24.74	25.60	26.36	27.07	27.71	28.30	28.82	29.37	29.87	30.36
800	24.40	25.30	26.18	26.93	27.66	28.32	28.93	29.46	30.02	30.53	31.04
810	24.94	25.86	26.76	27.51	28.26	28.93	29.56	30.13	30.68	31.20	31.72
820	25.49	26.43	27.33	28.09	28.89	29.55	30.19	30.78	31.34	31.88	32.41
830	26.03	27.00	27.89	28.71	29.49	30.20	30.85	31.46	32.01	32.56	33.11
840	26.57	27.54	28.48	29.31	30.08	30.81	31.48	32.10	32.66	33.22	33.78
850	27.13	28.11	29.08	29.90	30.72	31.46	32.12	32.78	33.33	33.91	34.48
860	27.66	28.70	29.65	30.53	31.34	32.10	32.77	33.45	34.01	34.60	35.19
870	28.22	29.29	30.26	31.16	31.96	32.77	33.46	34.15	34.72	35.33	35.90
880	28.79	29.88	30.88	31.79	32.58	33.44	34.11	34.82	35.44	36.03	36.62
890	29.36	30.47	31.49	32.43	33.24	34.11	34.81	35.53	36.13	36.76	37.36
900	29.93	31.07	32.11	33.07	33.90	34.76	35.50	36.21	36.85	37.47	38.09
910	30.50	31.70	32.74	33.71	34.56	35.41	36.20	36.93	37.59	38.22	38.81
920	31.08	32.31	33.37	34.33	35.23	36.10	36.91	37.62	38.32	38.94	39.58
930	31.67	32.91	34.00	34.99	35.91	36.76	37.58	38.34	39.06	39.69	40.31
940	32.24	33.51	34.62	35.63	36.57	37.44	38.28	39.02	39.76	40.43	41.07
950	32.82	34.13	35.26	36.29	37.25	38.14	39.00	39.75	40.51	41.19	41.81
960	33.41	34.75	35.90	36.95	37.93	38.81	39.72	40.49	41.26	41.96	42.59
970	34.01	35.40	36.55	37.62	38.62	39.52	40.45	41.23	42.02	42.74	43.38
980	34.61	36.03	37.20	38.29	39.31	40.23	41.18	41.98	42.75	43.51	44.17
990	35.21	36.70	37.89	39.01	40.05	40.94	41.91	42.73	43.51	44.30	44.97
1000	35.85	37.33	38.54	39.68	40.75	41.70	42.65	43.49	44.28	45.08	45.77

[1]25.55 lb. per ft. For 29.35 lb. line pipe the pressure drop is approximately 5.4% greater.

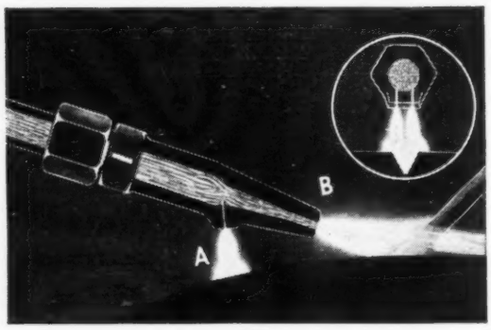
Superior pipe-line welds
made with Lindewelding



A scene during the construction of an eight-inch oil line Multi-Flame Lindewelded near Hoesington, Kansas.

THE unique metallurgy and simplified technique of Lindewelding enable you to make pipe-line welds of unequaled tensile strength, ductility, soundness and corrosion resistance. The properly made Lindeweld is consistently as dependable as the pipe base metal. It makes the life of the pipe line entirely dependent upon the durability of the pipe and fittings. Also, Lindewelding can be done rapidly and economically, even under varied field conditions.

Why not take advantage of the benefits of Lindewelding on your next pipe-line project? Assistance in organizing and training for this improved method of joining pipe by oxy-acetylene welding is available from the nearest Linde office. Write for a copy of the useful booklet "Lindewelding Pipe Lines." The Linde Air Products Company, Unit of Union Carbide and Carbon Corporation, New York and principal cities.



When conditions permit, the Multi-Flame Lindewelding head, shown in cross section, is recommended. The small flames, A, preheat the pipe while the main flame, B, melts the welding rod and postheats the weld. In the circle is a cross-sectional view through the preheating flames, A.

Everything for Oxy-Acetylene Welding and Cutting

LINDE OXYGEN • PREST-O-LITE ACETYLENE • OXWELD APPARATUS AND SUPPLIES FROM UCC LINDE UNION CARBIDE

CAPACITY OF NARROW DRUM OF LARGE A.P.I. STANDARD[1] SAND REEL, FT. OF LINE

Total depth[2] of winding, in.	Size of line, in.								
	1/4	9/32	5/16	3/8	7/16	1/2	9/16	5/8	3/4
1/4	178								
1/2	364	290	235	163	120	92			
3/4	557	443	359	249	183	141	111	90	62
1	757	602	488	339	249	191	151	122	85
1 1/4	965	768	621	431	318	244	192	156	108
1 1/2	1179	938	760	527	388	298	235	191	132
1 3/4	1401	1115	903	627	461	354	279	226	157
2	1631	1298	1051	729	537	412	325	263	182
2 1/4	1867	1486	1203	835	615	471	372	302	209
2 1/2	2111	1680	1360	944	695	533	420	341	236
2 3/4	2362	1880	1522	1056	778	596	470	382	264
3	2621	2085	1688	1172	863	662	522	423	293
3 1/4	2887	2297	1860	1291	951	729	575	466	323
3 1/2	3160	2514	2035	1413	1041	798	629	510	353
3 3/4	3440	2737	2216	1538	1133	868	685	556	384
4	3727	2966	2401	1667	1228	941	742	602	417
4 1/4	4022	3200	2591	1798	1325	1015	801	659	450
4 1/2	4324	3441	2786	1933	1424	1092	861	699	483
4 3/4	4634	3687	2985	2072	1526	1170	922	749	518
5	4950	3939	3189	2213	1630	1250	985	800	553
5 1/4	5274	4197	3398	2358	1737	1331	1047	852	590
5 1/2	5606	4460	3611	2506	1846	1415	1116	906	627
5 3/4	5944	4730	3829	2658	1958	1500	1183	960	664
6	6290	5005	4052	2812	2071	1588	1252	1016	703
6 1/4	6643	5286	4280	2970	2188	1677	1322	1073	743
6 1/2	7003	5572	4512	3131	2306	1768	1394	1131	783
6 3/4	7371	5865	4749	3296	2427	1861	1467	1191	824
7	7746	6163	4990	3463	2551	1955	1542	1251	866
7 1/4	8128	6467	5236	3634	2677	2052	1618	1313	909
7 1/2	8518	6777	5487	3808	2805	2150	1695	1376	952
7 3/4	8914	7093	5743	3986	2936	2250	1774	1440	996
8	9318	7414	6003	4166	3069	2352	1855	1505	1042
8 1/4	9730	7742	6268	4350	3204	2456	1937	1572	1088
8 1/2	10148	8075	6538	4538	3342	2562	2020	1639	1134
8 3/4	10574	8414	6813	4728	3482	2669	2105	1708	1182
9	11007	8758	7091	4922	3625	2778	2191	1778	1230
9 1/4		9109	7375	5118	3770	2890	2279	1849	1280
9 1/2		9465	7663	5319	3918	3003	2368	1922	1330
9 3/4		9827	7956	5522	4067	3117	2458	1995	1381
10		10195	8254	5729	4220	3234	2550	2070	1432
10 1/4		10569	8557	5939	4374	3352	2644	2145	1485
10 1/2		10948	8865	6152	4532	3473	2739	2223	1538
10 3/4			9176	6368	4690	3595	2836	2301	1592
11			9496	6588	4853	3719	2933	2380	1647
11 1/4			9814	6811	5016	3845	3032	2461	1703
11 1/2			10140	7038	5184	3973	3133	2542	1759
11 3/4			10470	7267	5352	4103	3235	2626	1817
12			10806	7500	5524	4234	3338	2710	1874
12 1/4			11145	7736	5697	4367	3444	2795	1934
12 1/2				7975	5874	4502	3550	2881	1994
12 3/4				8217	6053	4639	3658	2969	2054
13				8463	6233	4777	3767	3058	2116

[1]Narrow drum diameter, 12 in., width, 14 in., flange diameter, 40 in.
[2]Distance from shaft to outside surface of outer layer.

62 YEARS

"FLEX-SET" Preformed YELLOW STRAND

THAT'S a long time to make nothing but wire rope—way over half a century! Just think of all the problems that have been solved and the solutions filed away to benefit today's wire rope users.

In oil fields everywhere, drillers are profiting by the continuous experience of Broderick & Bascom, dating from the moment wire lines began to be used.

On rotaries, B & B "Flex-Set" Preformed Yellow Strand is fast supplanting standard Yellow Strand, which long ago gained a reputation as a super rotary line.

"Flex-Set" Preformed Yellow Strand contains the same wonderful wire as standard Yellow Strand. The only difference is this: The wires and strands are permanently shaped to a helical form before they go into the rope. This difference makes a big difference in the characteristics, and in the life of the rope.

It is limp, easy to handle and install. Practically pre-broken in, it can be operated on full load and at full speed sooner, with less danger of damage. It spools evenly, operates smoothly, and is highly resistant to drum crushing, kinking and metal fatigue.

Try "Flex-Set" Preformed Yellow Strand Rotary Lines for long, economical service.

BRODERICK & BASCOM ROPE CO., ST. LOUIS

Houston Branch: 1311 Palmer St., Houston, Texas

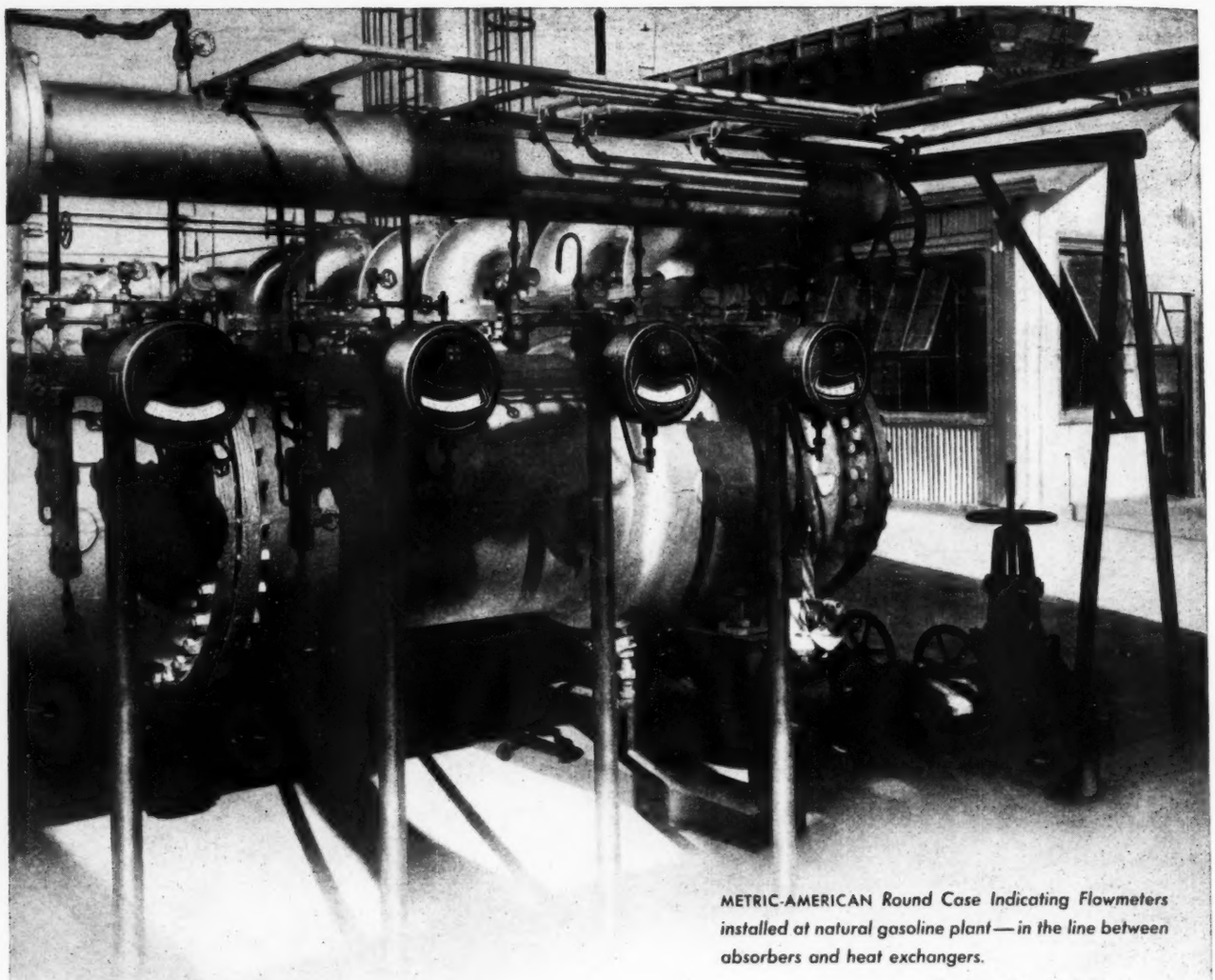
V-18R3

The Continental Supply Co.

Mid-Continent and
Rocky Mountain Distributors

PROPERTIES OF CONSTITUENTS OF NATURAL GASOLINE

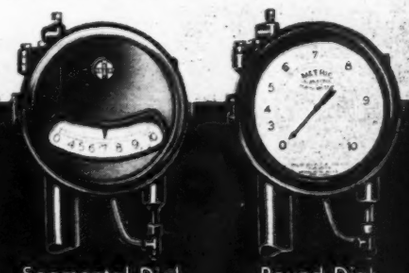
Property	Constituent						
	Ethane	Propane	Butane	Iso-butane	Pentane	Iso-pentane	Hexane
Empirical formula	C_2H_6	C_3H_8	C_4H_{10}	C_4H_{10}	C_5H_{12}	C_5H_{12}	C_6H_{14}
Molecular weight	30.05	44.06	58.08	58.08	72.10	72.10	86.11
Specific gravity of gas (A=1)	1.038	1.523	2.007	2.007	2.491	2.491	2.976
Density, gas, lb. per cu. ft.	0.07949	0.11656	0.15365	0.15365	0.19074	0.19074	0.22780
Cu. ft. gas per lb.	12.579	8.579	6.508	6.508	5.243	5.243	4.390
Cu. ft. gas per gal. liquid	39.41	36.42	31.62	30.59	27.58	27.32	24.26
Specific gravity of liquid	0.3758	0.5092	0.5827	0.5637	0.631	0.625	0.663
A. P. I. gravity of liquid	245	146	111	120	93	95	82
Lb. per gal. liquid	3.133	4.245	4.858	4.700	5.261	5.211	5.527
Gal. per lb. liquid	0.319	0.236	0.206	0.213	0.190	0.192	0.181
Boiling point, deg. fahr.	—127.5	—44	30.9	10.0	97.0	82.4	156.0
Melting point, deg. fahr.	—278	—310	—211	—229	—204	—256	—138
Critical temp., deg. fahr.	90	207	304	273	387	370	455
Critical pressure, lb. per sq. in.	723	654	542	536	486	484	435
Specific heat of gas, C_p, B.t.u./lb.	0.505	0.473	0.456	0.462	0.448	0.448	0.442
Specific heat of gas, C_p, B.t.u./cu. ft.	0.0406	0.0566	0.0728	0.0731	0.0854		0.1006
C_p/C_v	1.22	1.13	1.108	1.110			
Heat of vaporization, B.t.u. per lb.	210	182	164	158	154	158	143
Heat of vaporization, B.t.u. per gal.	658	773	797	743	810	823	790
Heating value, B.t.u. per cu. ft. gas	1,795	2,580	3,350	3,266	4,007	4,012	4,730
Heating value, B.t.u. per lb.	21,990	21,300	20,900	20,800	20,900	21,100	20,800
Heating value, B.t.u. per gal. liquid	68,600	90,400	101,500	97,800	109,900	109,900	115,000
Lower inflammability limit, %	3.2	2.3	1.9	1.9	1.4		
Upper inflammability limit, %	12.5	9.5	8.5	8.4	8.0		
Mean coefficient of expansion, 0°—50° F.	.0028	.00143	.00096	.00113	.00081		.00070
Mean coefficient of expansion, 50°—100° F.		.00180	.00113	.00128	.00089		.00078



METRIC-AMERICAN *Round Case Indicating Flowmeters installed at natural gasoline plant—in the line between absorbers and heat exchangers.*

The flowmeter goes modern...

Advanced design . . . greater simplicity . . . maintained fine accuracy . . . • A thoroughly modernized instrument which has promptly become a favorite in the industry! Every part is accessible for cleaning and adjustment. Float lever can be adjusted without disturbing the other working parts. By simply removing top, a low pressure test can be run and float action observed. • The Round Case Flowmeter consists of a modified U-gage with mercury seal, and a sturdy, attractively-designed case to enclose indicator and dial. A steel float, actuated by the rise of the mercury, is attached by lever to a horizontal bearing shaft which extends through an adjustable lapped stainless steel stuffing-box into the case. The differential gage is constructed of forged steel throughout. • Complete data furnished on the applications and operation of METRIC-AMERICAN Indicating Flowmeters. Or Recording and Integrating Flowmeters. 867



Segmental Dial Round Dial

ESTABLISHED 1836

AMERICAN METER COMPANY

INCORPORATED

Measurement and control of Gas, Oil, Steam, Air and Liquids

METRIC METAL WORKS *ERIE, PENNSYLVANIA*

NET WEIGHT OF CASING, LB. PER 100 FT., FLOATED IN FLUIDS OF DIFFERENT DENSITIES

Casing size, O.D., in.	Weight, lb. per 100 ft.	Displacement, gal. per 100 ft.	Density of well fluid, lb. per gal.												
			8½	9	9½	10	10½	11	11½	12	12½	13	13½	14	14½	15
9⅝	3600	377.97	387	198	9											
	3800		587	398	209	20										
	4000		787	598	409	220	31									
	4200		987	798	609	420	231	42								
	4350		1137	948	759	570	381	192	3							
10	3300	408.00														
10¾	4050	471.50	42													
	4550		542	307	71											
	5100		1092	857	621	385	149									
	5550		1542	1307	1071	835	599	364	128							
11¾	4700	563.30														
	5400		612	330	49											
	6000		1212	930	649	367	85									
12	4000	587.52														
13	4000	689.52														
	4500															
	5000															
	5400															
13⅜	4800	729.87														
	5450															
	6100															
	6800		596	231												
14	5000	799.68														
16	5500	1044.48														
	6500															
	7000															
	7500															
	8400															
18⅝	7800	1415.31														
	8750															
	9650															
20	9000	1632.00														
21½	9250	1885.98														
	10300															
	11400															
24½	10050	2449.02														
	11300															

Where no values are shown the weight of the fluid displaced exceeds that of the casing. Therefore the casing would float in fluid of that density.

RUNNING IN THE HOLE AT
THE RATE OF A MILE IN FIVE MINUTES

Coring oil wells, like all other modus operandi, has speeded up tremendously. Consider the speed at which the Elliott Wire Line Core Drill drops in the hole—500 - 1200 feet per minute—and the time required for getting the cutter head in coring position on bottom as compard to previous methods. Five to twelve minutes in a six thousand foot well; and no particular restriction on speed, other than that of safety, for retrieving the inner barrel with its core.

Speed that cuts coring costs to minimum, at the same time raising the standard of core recovery to the highest degree ever attained.

If you core your wells you cannot afford to ignore this modern, high speed coring tool. Write for illustrated, descriptive Bulletin No. 37-W and get the facts on *today's* method of coring oil wells.

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CORE DRILLING
COMPANY

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ELLIOTT CORE DRILLING COMPANY
4731 East 52nd Drive, Los Angeles, California, U. S. A.
Export Office: 420 Lexington Avenue, New York City

WI R ACT E CO L an RI G AS BLY

ELLIOTT

BELT SPEED, FT. PER MINUTE

Diam. of pulley, in.	Revolutions of pulley per minute																													
	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	275	300	325	350	375	400	425	450	475
2	26	31	37	42	47	52	58	63	68	73	79	84	89	94	99	105	110	115	120	126	131	144	157	170	183	196	209	223	236	249
2½	33	39	46	52	59	65	72	78	85	92	98	105	111	118	124	131	137	144	150	157	163	180	196	212	229	245	262	278	294	311
3	39	47	55	63	71	78	86	94	102	110	118	126	133	141	149	157	165	173	181	188	196	216	236	255	275	295	314	334	353	373
3½	46	55	64	73	82	92	101	110	119	128	137	146	156	165	174	183	192	201	211	220	229	252	275	298	321	343	367	390	412	435
4	52	63	73	84	94	105	115	126	136	147	157	168	178	188	199	209	220	230	241	251	262	288	314	340	367	393	419	445	471	497
4½	59	71	83	94	106	118	130	141	153	165	177	189	200	212	224	236	248	259	271	283	295	324	354	383	412	442	471	500	530	560
5	65	79	92	105	118	131	144	157	170	183	196	209	223	236	249	262	275	288	301	314	327	360	393	425	458	491	524	556	589	622
5½	72	86	101	115	130	144	159	173	187	202	216	231	245	259	274	288	303	317	331	346	360	396	432	468	504	540	576	612	648	684
6	79	94	110	126	141	157	173	188	204	220	236	251	267	283	298	314	330	346	361	377	393	432	471	511	550	589	628	668	707	746
7	92	110	128	147	165	183	202	220	238	257	275	293	312	330	348	367	385	403	421	440	458	504	550	596	641	687	733	779	825	870
8	104	126	147	168	188	209	230	251	272	293	314	335	356	377	398	419	440	461	482	503	524	576	628	681	733	785	838	890	942	995
9	118	141	165	188	212	236	259	283	306	330	353	377	401	424	448	471	495	518	542	565	589	648	707	766	825	884	942	1001	1060	1119
10	131	157	183	209	236	262	288	314	340	367	393	419	445	471	497	524	550	576	602	628	655	720	785	851	916	982	1047	1113	1178	1244
11	144	173	202	230	259	288	317	346	374	403	432	461	490	518	547	576	605	634	662	691	720	792	864	936	1008	1080	1152	1224	1296	1368
12	157	188	220	251	283	314	346	377	408	440	471	503	534	565	597	628	660	691	723	754	785	864	942	1021	1100	1178	1257	1335	1414	1492
13	170	204	238	272	306	340	374	408	442	476	511	545	579	613	647	681	715	749	783	817	851	936	1021	1106	1191	1276	1361	1446	1532	1617
14	183	220	257	293	330	367	403	440	476	513	550	586	623	660	696	733	770	806	843	880	916	1008	1100	1191	1283	1374	1466	1558	1649	1741
15	196	236	275	314	353	393	432	471	511	550	589	628	668	707	746	785	825	864	903	942	982	1080	1178	1276	1374	1473	1571	1669	1767	1865
16	209	251	293	335	377	419	461	503	545	586	628	670	712	754	796	838	880	922	963	1005	1047	1152	1257	1361	1466	1571	1676	1780	1885	1990
17	223	267	312	356	401	445	490	534	579	623	668	712	757	801	846	890	935	979	1024	1068	1113	1224	1335	1446	1558	1669	1780	1892	2003	2114
18	236	283	330	377	424	471	518	565	613	660	707	754	801	848	895	942	990	1037	1084	1131	1178	1296	1414	1532	1649	1767	1885	2003	2121	2238
19	249	298	348	398	448	497	547	597	647	696	746	796	846	895	945	995	1045	1094	1144	1194	1244	1368	1492	1617	1741	1865	1990	2114	2238	2363
20	262	314	367	419	471	524	576	628	681	733	785	838	890	942	995	1047	1100	1152	1204	1257	1309	1440	1571	1702	1833	1964	2094	2225	2356	2487
21	275	330	385	440	495	550	605	660	715	770	825	880	935	990	1045	1100	1155	1210	1264	1319	1374	1512	1649	1787	1924	2062	2199	2337	2474	2611
22	288	346	403	461	518	576	634	691	749	806	864	923	979	1037	1094	1152	1210	1267	1325	1382	1440	1584	1728	1872	2016	2160	2304	2448	2592	2736
23	301	361	421	482	542	602	662	723	783	843	903	963	1024	1084	1144	1204	1264	1325	1385	1445	1505	1656	1806	1957	2107	2258	2409	2559	2710	2860
24	314	377	440	503	565	628	691	754	817	880	942	1005	1068	1131	1194	1257	1319	1382	1445	1508	1571	1728	1885	2042	2199	2356	2513	2670	2827	2985
26	340	408	476	545	613	681	749	817	885	953	1021	1089	1157	1225	1293	1361	1429	1497	1566	1634	1702	1872	2042	2212	2382	2553	2723	2893	3063	3233
28	367	440	513	586	660	733	806	880	953	1026	1100	1173	1246	1319	1393	1466	1539	1613	1686	1759	1833	2016	2199	2382	2566	2749	2932	3115	3299	3482
30	393	471	550	628	707	785	864	942	1021	1100	1178	1257	1335	1414	1492	1571	1649	1728	1806	1885	1964	2160	2356	2553	2749	2945	3142	3338	3534	3731
32	419	503	586	670	754	838	923	1005	1089	1173	1257	1340	1424	1508	1592	1676	1759	1843	1927	2011	2094	2304	2513	2723	2932	3142	3351	3560	3770	3979
34	445	534	623	712	801	890	979	1068	1157	1246	1335	1424	1513	1602	1691	1780	1869	1958	2047	2136	2225	2448	2670	2893	3115	3338	3560	3783	4006	4228
36	471	565	660	754	848	942	1037	1131	1225	1319	1414	1508	1602	1696	1791	1885	1979	2133	2168	2262	2356	2592	2827	3063	3299	3534	3770	4006	4241	4477
38	497	597	696	796	895	995	1094	1194	1293	1393	1492	1592	1691	1791	1890	1990	2089	2249	2288	2388	2487	2736	2985	3233	3482	3731	3980	4228	4477	4725
40	524	628	733	838	942	1047	1152	1257	1361	1466	1571	1676	1780	1885	1990	2094	2199	2364	2409	2513	2618	2880	3142	3403	3665	3927	4189	4451	4712	4974
42	550	660	770	880	990	1100	1210	1319	1429	1539	1649	1759	1869	1979	2089	2199	2309	2479	2529	2639	2749	3024	3299	3574	3848	4123	4398	4673	4948	5223
44	576	691	806	923	1037	1152	1267	1382	1497	1613	1728	1843	1958	2073	2189	2304	2419	2594	2649	2765	2880	3168	3456	3744	4032	4320	4608	4896	5184	5472
46	602	723	843	963	1084	1204	1325	1445	1566	1686	1806	1927	2047	2168	2288	2409	2519	2709	2770	2890	3011	3312	3613	3914	4215	4516	4817	5118	5419	5720
48	628	754	880	1005	1131	1257	1382	1508	1634	1759	1885	2011	2136	2262	2388	2513	2629	2825	2890	3016	3142	3456	3770	4084	4398	4712	5027	5341	5655	5869
50	655	784	916	1047	1178	1309	1440	1571	1702	1833	1964	2094	2225	2346	2487	2618	2739	2940	3011	3142	3273	3600	3927	4254	4582	4909	5236	5563	5891	6218
52	681	816	953	1089	1225	1361	1497	1634	1770	1906	2042	2178	2314	2440	2587	2723	2849	3055	3131	3267	3403	3744	4084	4424	4765	5105	5445	5786	6126	6466
54	707	847	990	1131	1272	1414	1555	1696	1838	1979	2121	2262	2403	2535	2686	2827	2959	3170	3252	3393	3534	3888	4241	4595	4948	5301	5655	6009	6361	
56	733	879	1026	1173	1319	1466	1613	1759	1906	2053	2199	2346	2492	2629	2786	2932	3069	3285	3372	3519	3665	4032	4398	4765	5131	5498	5864	6231		
58	759	910	1063	1215	1367	1518	1670	1822	1974	2126	2278	2430	2581	2723	2885	3037	3179	3401	3492	3644	3796	4176	4555	4935	5315	5694	6074			
60	785	941	1100	1257	1414	1571	1728	1885	2042	2199	2356	2513	2670	2817	2985	3142	3289	3516	3613	3770	3927	4320	4712	5105	5498	5891	6284			
66	864	1036	1210	1382	1555	1728	1901	2073	2246	2419	2592	2765	2937	3100	3283	3456	3619	3861	3974	4147	4320	4752	5184	5616	6047	6480				
72	989	1130	1319	1508	1696	1885	2073	2262	2450	2639	2827	3016	3204	3383	3581	3770	3948	4207	4335	4524	4712	5184	5655	6126						
78	1047	1224	1429	1634	1838	2042	2246	2450	2655	2859	3063	3267	3471	3666	3880	4084	4278	4552	4697	4901	5105	5616	6123							
84	1126	1318	1539	1759	1979	2199	2419	2639	2859	3079	3299	3519	3739	3948	4178	4398	4607	4898	5058	5278	5498	6044	6594							
90	1204	1413	1649	1885	2121	2356	2592	2827	3063	3299	3534	3770	4006	4231	4477	4712	4937	5244	5419	5655	5891	6476								
96	1283	1507	1759	2011	2262	2513	2765	3016	3267	3519	3770	4021	4273	4514	4775	5027	5267	5589	5781	6029	6280									
102	1361	1601	1869	2136	2403	2670	2937	3204	3471	3739	4006	4273	4540	4797	5074	5341	5597	5935	6139	6406										
108	1440	1695	1979	2262	2545	2827	3110	3393	3676	3958	4241	4524	4807	5079	5372	5655	5927	6217												
114	1518	1790	2089	2388	2686	2985	3283	3581	3880	4178	4477	4775	5074	5362	5671	5969	6264													
120	1597	1884	2199	2513	2827	3142	3456	3770	4084	4398	4712	5027	5341	5635	5969	6280														
132	1754	2072	2419	2765	3110	3456	3801	4147	4492	4838	5184	5529	5875	6217	6563															
144	1911	2261	2639	3016	3393	3770	4147	4524	4901	5278	5655	6029	6406																	
156	2068	2449	2859	3267	3675	4084	4492	4901	5309	5571	6123																			
168	2225	2638	3079	3519	3958	4398	4838	5278	5718	6154																				
180	2382	2826	3299	3770	4241	4712	5184	5655	6123																					
192	2513	3016	3519	4021	4525	5027	5529	6029																						

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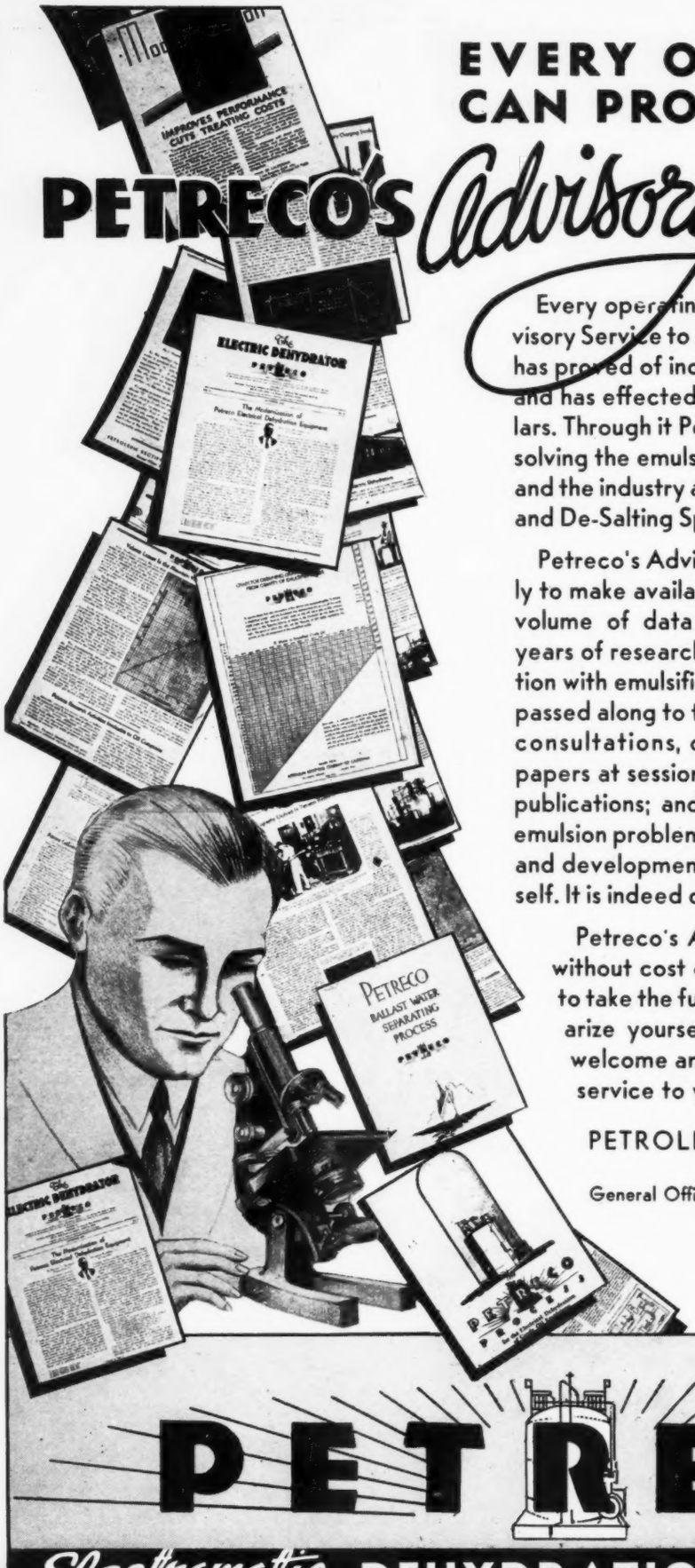
APPROXIMATE[1] SPECIFIC HEAT OF LIQUID PETROLEUM, B.t.u. PER LB. PER DEG. FAHR.

Temperature, deg. fahr.	Gravity, deg. A. P. I.						
	10	20	30	40	50	60	70
0	0.360	0.384	0.404	0.425	0.434	0.450	0.470
25	0.374	0.399	0.419	0.439	0.449	0.466	0.486
50	0.388	0.414	0.434	0.454	0.464	0.482	0.502
75	0.402	0.428	0.448	0.468	0.480	0.498	0.519
100	0.416	0.442	0.462	0.483	0.495	0.514	0.535
125	0.430	0.456	0.477	0.497	0.510	0.530	0.551
150	0.444	0.471	0.491	0.512	0.526	0.546	0.568
175	0.458	0.485	0.505	0.526	0.541	0.562	0.584
200	0.472	0.499	0.520	0.541	0.556	0.578	0.600
225	0.486	0.513	0.534	0.555	0.571	0.594	0.616
250	0.500	0.528	0.548	0.570	0.586	0.610	0.632
275	0.514	0.542	0.563	0.584	0.602	0.626	0.649
300	0.528	0.556	0.577	0.599	0.617	0.642	0.665
325	0.542	0.570	0.591	0.613	0.632	0.658	0.681
350	0.556	0.585	0.606	0.627	0.648	0.674	0.698
375	0.570	0.599	0.620	0.642	0.663	0.690	0.714
400	0.584	0.613	0.634	0.656	0.678	0.706	0.730
425	0.598	0.628	0.649	0.671	0.693	0.722	
450	0.612	0.642	0.663	0.685	0.708	0.738	
475	0.626	0.656	0.677	0.700	0.724	0.754	
500	0.640	0.670	0.692	0.714	0.739	0.770	
525	0.654	0.685	0.706	0.729	0.754		
550	0.668	0.699	0.720	0.743	0.770		
575	0.682	0.713	0.735	0.758	0.785		
600	0.696	0.727	0.749	0.772	0.800		
625	0.710	0.742	0.763	0.787	0.815		
650	0.724	0.756	0.778	0.801			
675	0.738	0.770	0.792	0.816			
700	0.752	0.784	0.806	0.830			
725	0.766	0.799	0.821	0.844			
750	0.780	0.813	0.835				
775	0.794	0.827	0.849				
800	0.808	0.841	0.864				
825	0.822	0.856					
850	0.836	0.870					
875	0.850	0.884					
900	0.864	0.899					

[1]Specific heats will vary from about 9% below these figures (typical naphthenic base oil) to about 4% higher (paraffinic stock).

EVERY OIL COMPANY CAN PROFIT THROUGH PETRECO'S *Advisory* SERVICE



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Petreco's Advisory Service is maintained especially to make available to oil companies the enormous volume of data and experience acquired through years of research and development work in connection with emulsified oil. This data and experience is passed along to the petroleum industry by means of consultations, correspondence, presentation of papers at sessions of technical groups, and in various publications; and is utilized continuously for solving emulsion problems; exactly as though all this research and development were sponsored by the industry itself. It is indeed comprehensive—and unique.

Petreco's Advisory Service is available to you without cost or obligation. In fact, you are urged to take the fullest advantage of it. At least, familiarize yourself with all its aspects. Petreco will welcome an opportunity to explain this valuable service to you in detail at your convenience.

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